TECHNICAL REPORT
67-25-CD

STORAGE STABILITY OF CIVIL DEFENSE SHELTER RATIONS

By

J. G. Woodroof
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University Of Georgia
Georgia Experiment Station
Experiment, Georgia

Contract No. DA 19-129-QM-2050 (N)

October 1966

UNITED STATES ARMY
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Project reference:
OCD-OS-62-156

October 1966

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FOREWORD

In 1962, the Civil Defense Shelter Program was underway and large quantities of food were procured and placed in warehouses or in selected shelters against a possible need during a national emergency. The types of food items utilized represented new formulations and new processing procedures which had not been procured before. Therefore, there was little or no information available regarding the storage stability for a 5-year period. Also the hermetically sealed metal containers selected for the storage of the foods had not been tested in conjunction with these specific products for a 5-year period under the variable conditions likely to exist in shelters where there may be no temperature and humidity control. It was to simulate conditions likely to exist in these shelters and to collect informational data at selected intervals over a 5-year period that this contract was proposed. This information was considered essential to the operation of the storage plan in providing current guidance as to the success or failure of the food items.

On 20 June 1962, Contract DA 19-129-QM-2050 was awarded by the U. S. Army Natick Laboratories to the Georgia Experiment Station, University of Georgia, to provide facilities and collect data that would lead to a determination of the long term storage stability and utility of Civil Defense shelter rations and the containers in which they were stored. Authorization for this contract is included in Work Order No. OCD-OS-62-156 between Department of the Army, Office of Secretary of the Army, Office of Civil Defense and Department of the Army, Army Materiel Command.

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ABSTRACT

Progress is reported on storage of (1) 4 lots of survival crackers, 4 lots of survival biscuits, and 2 lots of bulgur wafers for 36 months, and (2) 3 lots of carbohydrate supplement for 18 and 24 months, at 100°F/80% r.h., 100°/57%, 70°/80%, 70°/57%, 40°/57%, and 0°F. Two special cases of biscuits from approximately 42 months storage in a GSA common storage warehouse are also reported on. Data include (a) bursting strength, moisture, and general condition of V3c fiberboard cases, (b) corrosion, coating defects, and leakage of 2½-gal. and 5-gal. metal cans, (c) general package and product condition, (d) residual oxygen, fracture strength, moisture, peroxides, and free fatty acids of the wheat products, (e) moisture, pH, and sugars of the supplements, and (f) color, sensory quality and hedonic ratings for all products.

SUMMARY

Annual Report #IV includes results of examinations of stored shelter rations as follows:

Codes	Products	Storage Periods
CD1, 3, 5, 8	survival cracker	36 months
CD2, 4, 6, 7	survival biscuits	36 months
CSA*	" "	ca 42 months
CD9, 10	wafers, bulgur wheat	36 months
CD11, 12, 13	carbohydrate supplements	18 and 24 months

*Two cases (12 cans) from General Services Administration common storage warehouse, Seneca, Illinois.

I. Fiberboard Cases.

I.1. Bursting strength, inversely proportional to storage temperature, ranged from 91 psig below initial at 100°F to 51 psig above initial at 0° after 36 months in storage. Cases below 400 psig, initial mean 3.5%, ranged from 83% at 100° to 5% at 40° and 0°F, average 33%.

I.2. Moisture content, inversely proportional to temperature and directly proportional to relative humidity, remained practically unchanged during the 1965-66 period; mean contents ranged 7.0-12.2%. There was no indication of decrease in "wet strength" of the board.

I.3. General condition, of the cases remained satisfactory for continued storage.

I.4. Case markings remained essentially unchanged from condition as received.

II. Metal Cans.

II.1-3. External corrosion of cans remained essentially unchanged during the current period, excepting a moderate increase in panel rusting of 2½-gal. cans.

II.4. Coatings remained unchanged; no evidence of softening of flaking were observed.

II.5. Leaking cans did not increase during the third year, and no leaks were attributed to corrosion.

II. GSA. The 2½-gal. cans from General Services warehouse had slightly less corrosion and abrasion of coatings than did the cans from the CD study.

III. Rations.

III.A. Cereal Items.

III.A.1.a. Package seals and materials of glassine continued to increase in breakage by ca 3% seals and 2% packages per year, but results were quite variable; waxed paper remained a better wrapper, and cellophane a poorer wrapper than the glassine. GSA biscuits, in glassine, averaged 33% more broken packages than did the CD items.

III.A.1.b. Breakage of products, which increased quite erratically through 24 months, did not increase during the third year. GSA biscuits averaged 21% more breakage than CD biscuits and 12% more than half of the CD cracker items.

III.A.2.a. Sensory scores for appearance-color averaged as high as initial scores, the only differences being higher scores for lighter-baked items and a 0.15 reduction in samples from 100°F as compared to those from 0° storage.

III.A.2.b. Hunter color values continued to indicate moderate glazing of product surfaces and slight to moderate fading of red color at higher temperatures, with very slight browning in a few samples.

III.A.3. Fracture strength changed relatively little during the third year, continuing to indicate rather indefinite tendencies to increase slightly with time, particularly at lower temperatures.

III.A.4.a. Residual oxygen averaged slightly higher than at 24 months, current averages being ca 9% at 100°F, 14% at 70°, 16% at 40°, and 18.5% at 0°. Wafers remained lower than creackers and biscuits.

III.A.4.b. Moisture contents continued to exhibit no apparent relationship to storage time or temperature, varying only with items and products.

III.A.4.c. Peroxide values averaged slightly higher than after two years; free fatty acids increased seriously during the third year at 100°F, but not at 70° or below.

III.A.2-4. GSA biscuits were darker than the CD biscuits, moderately hard, and 0.7-2.0% lower in moisture than were the CD biscuits or crackers. Oxygen content of cans was "average", or under 18%, and the biscuits were not particularly stale or abnormal in peroxide and free fatty acid content.

III.A.5.a. Sensory scores for texture indicated no serious change with storage; aroma and flavor scores indicated borderline acceptability for crackers and two of four biscuits from 100°F at 36 months, but wafers were less affected by higher temperatures.

III.A.5.b. Hedonic ratings corresponded relatively closely with sensory scores, although somewhat higher and remaining above the borderline rating of 4.00 on palatability even from 100°F storage. GSA biscuits averaged slightly higher than did the CD items on sensory and hedonic scores.

III.A.5.c. Correlations of palatability, with other measurements continued to exhibit definite trends associated with storage temperatures, and to a lesser extent with storage time.

III.B. Carbohydrate Supplements.

III.B.1.a. Condition of bags changed during the second year by slight increase in number and extent of seam separations on seam test; only one item (CD13) had seams (ca 9%) which pulled completely apart.

III.B.1.b. Condition of candies exhibited no apparent association with storage variables, except moderate color, aroma and flavor changes as noted below.

III.B.2.a,b. Sensory scores for appearance and Hunter Color values indicated moderate darkening and slight glazing at higher temperatures. Maximum changes averaged ca 1.5 score points at 100°F, 0.5 at 70°, and results were quite variable within items.

III.B.4.b. Moisture content varied with items, averaged same as initial, with some suggestion of higher values from 0°F storage.

III.B.4.d. pH values varied only among items and in certain "odd" samples; a suggestion of lower values at 100°F, or higher at 0°, was not generally significant.

III.B.4.e. Sugar contents varied among items and odd samples, with no definite temperature effects; the only definite time effect was some increase in variability among samples.

III.B.5.a,b. Sensory scores and hedonic ratings for samples from 100°F storage averaged ca 1.1 and 0.5 lower than those from lower temperatures, because of loss of aroma and flavor and development of slight "terpene" character at 100°.

III.B.5.c. Correlations of palatability with other measurements were still largely indefinite, although certain temperature influences were suggested.

STORAGE STABILITY OF CIVIL DEFENSE SHELTER RATIONS

STUDY OF THE STORAGE STABILITY OF CONTAINERS AND FOOD PROCURED FOR THE CIVIL DEFENSE SHELTER PROGRAM

INTRODUCTION

Due to variations in periodic examination dates for the 13 items held in storage during the fourth year of the study, the total period covered by the present report was 9 November 1964 to 21 March 1966. Storage conditions for this period averaged (with standard deviations above and below averages) as follows:

Code	Temperature °F	Relative Humidity Percent
100/80	99.9, +1.6, -1.3	80.3, +3.5, -5.7
100/57	99.8, +1.7, -1.8	57.5, +3.1, -3.1
70/80	70.1, +0.8, -1.0	80.6, +2.3, -2.7
70/57	70.1, +1.4, -1.3	57.9, +3.2, -3.1
40/57	40.3, +2.0, -2.0	56.9, +3.6, -4.0
0/amb	0.1, +3.0, -1.4	ambient

As noted in previous reports, deviations in storage conditions were those recorded in center air spaces in the rooms, resulting largely from opening doors for inspection, maintenance, and removal of samples--considerably smaller fluctuations may be assumed inside cases and cans.

Products and examinations included in the report are as follows:

Code	Product	Contract	Storage Periods
CD1	Cracker	2692-62	36 months
CD3	Cracker	2689-62	36 months
CD5	Cracker	2687-62	36 months
CD8	Cracker	2691-62	36 months
CD2	Biscuit	2686-62	36 months
CD4	Biscuit	2694-62	36 months
CD6	Biscuit	2688-62	36 months
CD7	Biscuit	2687-62	36 months
GSA*	Biscuit	1957-62	ca 42 months
CD9	Bulgur wafer, white	2254-62	36 months
CD10	Bulgur wafer, red	2254-62	36 months
CD11	Carbohydrate supplement	24018-63	18 and 24 months
CD12	Carbohydrate supplement	24016-63	18 and 24 months
CD13	Carbohydrate supplement	24023-63	18 and 24 months

*Two cases (12 cans) of biscuits, pack code 8920-823-7367, from General Services Administration common storage warehouse, Seneca, Illinois.

Examinations of samples from the six storage conditions at the three periods included one case and two cans per sample, with the exception that two cases of biscuits with six cans each were examined from the GSA common storage warehouse.

Statistical treatment and arrangement of data were essentially as described in Report #III, p.6 (19 July 1965).

RESULTS

I. Fiberboard (V3c) Cases

Samples of items CD2 and CD5-CD13, packed 2 cans (5-gal.) per case, consisted of 1 entire case; those of items CD1, CD3 and CD4, packed 6 cans ($2\frac{1}{2}$-gal.) per case, included only 1/3 case. The 36-months samples of CD1 were the second from cases opened at 24 months, while those of CD3 and CD4 were the final 1/3 of cases examined at 18 and 24 months.

Data for cases of bakery items (A) and carbohydrate supplements (B) are reported together in this section.

I.A.B.1. Bursting Strength. (Table 1)

Bursting strength of the cases continued to decrease at 100°F, with some increase at 40° and 0°F, during the third year of storage of the cereal items. Results were less definite for the second year with the carbohydrate supplement cases. Mean changes from initial values for bursting strength at various periods of storage were as follows:

Bursting strength, change from initial: (pounds)

Months	Bakery Item Cases				Carbohydrate Supplement Cases			
temp., F.	6-12	18-24	36	±	6-12	18	24	±
100°	-48	-74	-91	40	-58	-27	-57	35
70°	- 1	-16	-11	38	-19	26	- 2	32
40°	22	22	37	33	6	39	- 2	22
0°	20	37	51	42	-12	37	30	63

All cases decreased at 100°F, and CD9, CD10, CD11 cases decreased at 70°. All except CD9, CD12, CD13 gained at 40°, and all except CD5, CD9 and CD13 gained at 0°. As seen above, variations were somewhat greater at 0°, particularly among candy item cases, than at higher temperatures.

With reference to the specified minimum bursting strength of 400 psig, 4 of 6 cases of CD5 and CD12 averaged below this value

(av 369) on initial examination, and numbers varying from 1 to 19 of other cases, excepting those of CD8, dropped below 400 psig during storage. Time and temperature patterns of these drops were as follows:

Bursting strength, percent of cases below 400 psig:

Months temp,F	Bakery Item Cases 0-12	18-24	36	Mean	Carbohydrate Supplement Cases 0-12	18	24	Mean
100°	31	61	83	53	67	67	67	67
70°	7*	8	11	8*	33*	17	17	27*
40°	6	0	0	2	33	33	33	33
0°	11	6	11	9	50	33	0	33
mean	14*	24	33	22*	44*	39	33	41*

*Includes initials.

By items, cases under 400 lbs averaged 5% for CD4 and 7; 12% for CD2, 6 and 11; 21% for CD1 and 3; 29% for CD9, 10 and 13; 58% for CD5 and 81% for CD12. Mean values for the cases under 400 lbs were 369 at 0-12 months, 372 at 18-24 months, 368 at 36 months; and 367 at 100°F, 380 at 70°, 373 at 40°, 374 at 0°; the lowest average was 314 in CD12, 100°/80% at 12 months. These data indicate relatively definite time effects at 100°F, less definite effects at 0°, with large variations in 70° and 40° results and in items.

I.A.B.2. Moisture Content. (Table 2)

There were no general trends for change of moisture content of cases during the third year of storage (second year for cases of carbohydrate supplement). The pattern of moisture directly proportional to relative humidity and inversely proportional to temperature may be seen in Table 2. Ranges among the 13 items at the current period, and differences and deviations of differences between current values and those of the previous storage year, were as follows:

Condition °F/% r.h.	Range current %	Mean Dif., last 12 mo. %	Std. Dev. of differences ±
100/80	0.9	.13	.16
100/57	1.0	.07	.38
70/80	1.5	-.10	.19
70/57	0.8	-.15	.25
40/57	1.6	.19	.61
0/amb	2.2	-.15	.48
Mean	-	-.04	.38

The standard errors of differences were ± .26 for condition means, ± .19 for item means, indicating by comparison with the data above that the only variations of significant magnitude were the ranges and deviations of items in rooms.

Mean correlations of moisture content with bursting strength were + .547 within items and + .534 within conditions. While accounting for less than 30% of the variance, the relationship is positive and statistically significant, indicating a slight tendency for bursting strength to increase instead of decrease with increased moisture; i.e., the "wet strength" characteristics of the cases were very good.

I.A.B.3. General Condition of Cases.

All cases remained in satisfactory condition for continued storage beyond the third year, although they were generally less "new" in appearance than were those received from ca $3\frac{1}{2}$ years of storage in the General Services Administration warehouse. The GSA cases apparently came from "inactive" storage, whereas rooms used in the present storage study are also employed for in-and-out storage of other types of packaged products, resulting in moderate amounts of "wearing" of the CD cases. There have, however, been no case failures even under these "active" conditions, and changes during the current storage year were very slight.

Loose seals. There were no pulled staples or unglued flaps; some evidence of inadequate spreading of adhesive on the flaps was observed in 14 of the 30 cases of CD3, 4, 5, 7 and 11. Rated on a 0-9 scale, this defect was noted in 4 cases initially, averaging 0.40 ± 0.34, or very slight. At 36 months (24 months in CD11), ratings among 13 cases from both 100° and 70°F averaged 0.58 ± .28 (up 0.36 ± .39 from the last year), whereas only 1 case (CD7, rated 0.6) was observed from 0°F and none from 40°F. With reference to storage humidity for the 13 cases from 100° and 70°, those from 80% averaged 0.59 ± .24 (up 0.31 ± .38), those from 57% averaged 0.57 ± .31 (up 0.41 ± .40). Hence some increase in "inadequate spreading" which might be attributed to slight loosening around the edges of the adhesive is suggested at the higher temperatures, apparently not influenced by differences in relative humidity, but the evidence to date is far from conclusive.

Delamination. One flap on each of 5 of the 60 cases of cereal products was partially delaminated; these were CD1 and CD4 from 70°/80% (average 1.75 ± .25) and CD8 and CD10 from 100°/57% and CD10 from 40°/57% (average 0.27 ± .17). As one case (CD4) was rated 4.0 for panel delamination from 70°/80% at 24 months, there appears to be some evidence of a tendency for delamination at this storage condition,

but an incidence of 5 cases averaging 2.5 ± 1.1 from 20 cases, with two of these involving flaps, is not considered serious deterioration.

Mold. Of the 245 cases examined after 12 to 36 months of storage above 0°F, small areas of mold were noted on the outside of 17 cases and inside 23 cases. These occurred as follows (rated at 0 = none to 9 = completely molded):

	12 & 18 mo.		24 months		36 months	
	cases	rating	cases	rating	cases	rating
outside mold:						
100°/80%	3	.83 ± .54	-		1	.50
70°/80%	5	1.12 ± .74	3	.83 ± .24	5	.48 ± .27
inside mold:						
100°/80%	2	.30 ± .10	5	.60 ± .36	3	.50 ± .10
70°/80%	1	.30	2	1.05 ± .45	5	.84 ± .76
57% r.h.	-			.50 ± .13	-	

For outside mold, these represent ca 6% of cases examined from 40°-100°F at 12-24 months (mean rating 0.96) and 12% at 36 months; inside mold ca 3% of cases at 12-18 months and 18% (mean rating 0.67) at 24-36 months. It is apparent that the major increase was in incidence, not in extent or severity--practically all mold observed was of the short-filament or "fuzzy" type, indicating very slow growth, and causing little or no damage to the cases.

Sweating of Cases. Evidences of moisture staining of outside of cases averaged as follows (rated at 0 = none to 9 = very severe):

Condition °F/% r.h.	Cereal Items 36 months	Carbohydrate Supplement 24 months
100/80	.65 ± .29	.73 ± .34
100/57	.39 ± .13	.80 ± .20
70/80	.73 ± .27	1.10 ± .70
70/57	.47 ± .22	.67 ± .34
40/57	.65 ± .20	.77 ± .17
0/amb	.28 ± .27	.60 ± .22
item mean	.53 ± .09	.78 ± .23

Ratings averaged .06 ± .23 higher than previous highs for the 10 cereal items, but .84 ± .23 lower for the 3 carbohydrate supplements. Current and previous higher ratings for the supplement cases apparently resulted from their having been stored later than were the cereal items, and therefore stored nearer the doors or

corners of the rooms where atmospheric fluctuations were more pronounced. None of the sweating has resulted in any real damage except to appearance, but it has probably contributed to the increased incidence of mold.

Sweating of cans in cases. Moisture staining of insides of cases and of outside surfaces of cans, while rated separately, have remained nearly the same, so are evaluated together. Average ratings, on the usual 0 to 9 scale, were as follows:

Condition °F/% r.h.	Cereal Items 36 months	Carbohydrate Supplement 24 months
100/80	.96 ± .40	1.07 ± .19
100/57	.57 ± .33	1.08 ± .32
70/80	.94 ± .41	1.02 ± .32
70/57	.58 ± .30	.97 ± .22
40/57	.49 ± .30	.88 ± .28
0/amb	.50 ± .22	.75 ± .22
item mean	.67 ± .24	.97 ± .12

Ratings averaged .00 ± .29 in comparisons with previous highs for the 10 cereal items, with an .18 ± .11 increase for supplement cases and cans. The five heavy-can items (CD9-CD13, weighing 71-78 lbs per case) averaged .35 ± .11 higher sweating inside cases than did the lighter items (CD1-CD8, weighing 34-40 lbs per case if the 6-can, 55 lb cases of $2\frac{1}{2}$ gal. cans are averaged at ca 36 lbs, since they are sampled three times). The tendency for moisture condensation to increase with density of packaged foods was previously demonstrated with commercial canned items.[a]

Collapse. As the best cases were marked for longest storage when received, the originally damaged cases had been used, and the stacks were one case shorter than at the previous examination period. This resulted in lower ratings for collapse (bulged panels and ends) than those received the year before, by an average of .34 less for cereal item cases and .60 less for cases of supplement.

The data indicates that the cases have apparently tended to "settle down", as temperature and humidity differences are less clearly defined than on some of the former examinations. There were no collapsed cans, so case "collapse" was not considered a serious problem in the 5-case stacks, now reduced to 4 cases in most stacks.

[a] E. K. Heaton, C. F. Kayan and J. G. Woodroof. 1957. Heat and Vapor Movement on Refrigerated Packaged Goods. Refrigerating Engineering 65(8):42.

Mean ratings by weight classes and storage conditions were as follows:

Case Wt. av. lbs.	Items CD	Collapse 36 months	Condition °F/% r.h.	Collapse 36 months cereal	Collapse 18-24 months supplement
34	2,7,8	.39 ± .33	100/80	.70 ± .34	.73 ± .25
40	5,6	.61 ± .42	100/57	.40 ± .27	.85 ± .32
55*	1,3,4	.51 ± .39	70/80	.55 ± .31	1.07 ± .46
71	9,10	.81 ± .46	70/57	.55 ± .50	.82 ± .27
78	11,12,13	.89 ± .33	40/57	.69 ± .49	.82 ± .21
			0/amb	.42 ± .46	1.08 ± .22

*Cases originally containing six $2\frac{1}{2}$-gal. cans, sampled at three periods each.

I.A.B.4. Condition of Markings.

The print and other markings on all cases was easily legible and generally little changed from initial condition. Mean values for cereal cases at 36 months and carbohydrate supplement cases at 24 months, as compared to initial ratings (usual 0 to 9 scale) were:

Storage	Fading of Markings cereal	Fading of Markings supplement	Blurring of Markings cereal	Blurring of Markings supplement
initial	.36 ± .28	.05 ± .05	.41 ± .41	.08 ± .07
100/80	.27 ± .22	.27 ± .24	.50 ± .25	.40 ± .00
100/57	.29 ± .11	.33 ± .17	.45 ± .22	.33 ± .05
70/80	.16 ± .16	.23 ± .23	.45 ± .22	.33 ± .13
70/57	.13 ± .13	.07 ± .05	.40 ± .22	.53 ± .17
40/57	.23 ± .16	.23 ± .21	.52 ± .20	.40 ± .00
0/amb	.15 ± .11	.17 ± .17	.41 ± .28	.37 ± .05
mean	.20 ± .15	.21 ± .18	.46 ± .23	.40 ± .09

The only significant difference is in the very low initial ratings for carbohydrate supplement cases; these were unusually clean when received, but appeared quite similar to the cereal item cases after two years in the various storage rooms.

I.A.B.1a-4a. Biscuits from General Services Warehouse.

Reference to Table 1 will show that the mean bursting strength of the GSA biscuit cases was 479 psig, case difference 8, rep deviation 31, as compared to the CD1, 3, 4 mean of 486 ± 40, rep

deviation 35 ± 7 for similar cases stored at 70°F/57% r.h. Moisture content of the GSA cases (Table 2) averaged 7.92%, case difference .10, rep deviation, .02; the CM, 3, 4 cases averaged 8.32 ± .21, rep deviation .04, after equalization at ca the same atmospheric conditions.

There was no evidence of mold outside or inside the two GSA cases examined, nor was there any delamination of the fiberboard. Glue was unevenly spread on the flaps, leaving loose corners (rating 1.0), but there was no loosening of areas where the adhesive had been applied. Evidence of outside sweating was rated 0.6 ± .0, of inside sweating 0.5 ± .3, moisture on cans 0.3 ± .3. Collapse rated 1.75 ± .25, largely because of punctures and dented corners which appeared to have occurred during shipping, after cases were removed from the warehouse.

The print and other markings were in good condition, rating 0.15 ± .14 for fading and 0.32 ± .22 for blurring--the slight blurring of a few areas also appeared to have resulted largely from shipping damage. In short, all indications were that the cases were in very good condition as they came from the General Services warehouse.

II. Metal Cans

II.A.B.1-3. Location, Severity and Type of Corrosion. (Tables 3 & 4)

There was relatively little change in corrosion during the third year of storage of cereal items, or second year for carbohydrate supplements, except a moderate increase on the 2½-gal. cans stored at 70°F.

External rusting. The location of external corrosion remained primarily along the "wiped" areas adjacent to seams, with the exception that considerable increases in panel and bottom rusting were observed on the 2½-gal. cans stored at both of the 70°F conditions, particularly those at 80% r.h. These averaged .65 above 24 months (scale 0 to 9) and .58 above previous high ratings. The smaller type cans at 70°/57% were also above previous ratings, by .26, and both of the 70° lots had more corrosion than corresponding cans at 100°. The 100°, 40° and 0° small cans averaged .03 ± .04 above 24 months values, i.e., no change, and were .10 ± .02 under previous high ratings, which occurred at 6-18 months while the cans from damaged cases were being utilized. The same was generally applicable to 5-gal. cans, which averaged .08 ± .16 less than at 24 months and .57 ± .55 less than previous highs for cereal items, and .08 ± .16 more than at 18 months but .26 ± .31 less than previous highs for the supplement cans. The small decreases in cereal cans were mostly at 80% r.h.,

while the equally slight increases in supplement cans were at 100° and 70°/57%. Types of rusting observed are shown in Tables 3 and 4; all cans were pitted, and a few had surface corrosion as well.

Internal corrosion. All internal corrosion was surface type, where products touched the can interior; as indicated in the tables, some of these contact areas were also slightly pitted. The only increases worth noting were in $2\frac{1}{2}$-gal. cans at 100° and 70° in 80% r.h.; the 100° cans averaged .25 above 24 months and .10 above previous highs, while the 70° increases were .40 and .13. The $2\frac{1}{2}$-gal. cans from other conditions averaged .08 ± .07 above 24 months, but .19 ± .16 below previous high ratings. Internal corrosion in the 5-gal. cans of cereal items averaged the same (± .12) as at 24 months but .19 ± .13 below previous highs, while that in supplement cans was .10 ± .13 above 18 months and the same (± .06) as previous maximum ratings.

Through the current periods of storage, external corrosion has been generally proportional to temperature and humidity (excepting the third-year increases in $2\frac{1}{2}$-gal. cans at 70°F) with no consistent relationship to product type or can weight; the temperature and humidity pattern has remained, however, less definite in the carbohydrate supplements. Internal corrosion has varied largely with items, with no apparent relationship to any other variable. Neither external nor internal corrosion has been associated with leaks, so the only significant detractions from product quality have been the unsightly staining of can and case surfaces (i.e., loss of "fresh product" appearance) and a slight metallic taste of some of the pieces of candy which were in contact with the can walls.

II.A.B.4. Defects of Can Coatings. (Table 5)

Again, as reported for previous examinations, no softening or other definite structural changes in can coatings were observed. Coating defects therefore remain lack of cover near seams and in scraped or otherwise damaged areas, with slight but, on the $2\frac{1}{2}$-gal. cans, increasing areas in which rust has loosened coating around thin or discontinuous spots on the panels. The extent of such loosening was quite minor at the third year, so defect ratings remained closely similar to ratings for external corrosion in that both resulted largely from areas having no coating.

The average ratings for coating defects were .13 ± .09 below those at 24 months and .18 ± .11 below previous highs for $2\frac{1}{2}$-gal. cans, .04 ± .05 below 24 months and .22 ± .17 under previous highs for 5-gal. cereal item cans, and .07 ± .13 below 18 months and .29 ± .16 under previous highs for cans of carbohydrate supplement. Thus prolonged storage resulted in less damage (actually practically none) than did disruption of the coatings in seaming and handling.

II.A.B.5. Leaking Cans. (Table 6)

As seen in Table 6, there have been no leaks in cans of wafer CD10, and only one questionable leaker in cracker CD8 and two in biscuit CD2. Leaks in biscuits CD4 and CD6 appear to have increased with storage, at least up to 24 months. Other leaks, ranging by items from ca 1.5 to 11.3 percent of all cans examined, were apparently not associated with storage time or condition.

All questionable leaks (very slow or interrupted bubbling on leak test, but some compositional evidence that the can had leaked) were in top seams or side seams adjacent to tops. So were 76 of the 89 unquestionable leaks found through the end of the third year (two years for carbohydrate supplements). These inadequate seals apparently resulted from bent can flanges in many instances, as lid flanges were flattened without proper insertion under the body flange--in a few cans a perceptible gap remained between body and lid. Of the other 13 leaking cans, 4 leaked through similarly defective bottom seams, 5 through seams opened by dents apparently incurred in shipping or handling, 1 at a pinhole made by a closing chuck, and 3 (carbohydrate supplement) as a result of lids so loosely crimped on that they were removable by hand.

II.A.B.1a-5a. Condition of Biscuit Cans from General Services Warehouse.

The GSA cans were in somewhat better general condition than were comparable 2½-gal. cans of items CD1, 3 and 4 from 70°F/57% r.h. (Tables 3, 5 and 6).

Comparable data were as follows:

	GSA Cans			CD1,3,4 cans: 70°/57%	
	mean	case dif.	can dif.	mean	can dif.
external corrosion	0.32	.03	.29	0.63 ± .31	.20 ± .00
internal corrosion	0.57	.13	.55	0.70 ± .00	.39 ± .20
coating defects	0.67	.13	.55	0.70 ± .20	.29 ± .10
leaking cans	0 in 12	-	-	1 in 6	1 in 2

Coating defects of these cans were primarily scratches and scraped areas from which coatings were missing.

III. The Rations

A. Cereal Items

III.A.1.a. Breakage of Package Seals and Wrapping Materials. (Table 7)

Seals Broken. There were still no broken seals in biscuits CD2 (waxed paper) and CD6 (cellophane; only 1 broken seal, at 24

months). Biscuit CD7 (waxed paper) averaged 1.04% (Table 7), which is 1.4% lower than at 18 months and 3.8% lower than at 24 months. Wafers CD9 and CD10 (waxed glassine) had 0.43% more broken seals than at 12-18 months, 0.14% more than at 24 months, but the CD10 mean of 1.32% at 36 months is the highest percentage of major seal breaks observed in these items. The other five items, biscuit CD4 and the four crackers (all in waxed glassine), averaged 13.2 ± 9.2% at 36 months, as compared to 9.0 ± 6.8% at 24 months and 5.3 ± 4.4% at 18 months. Three of these have increased at each examination period (CD1 was high at 18 months, CD5 unusually low at 36 months), and the general averages for broken glassine seals at 12-36 months were 0.22, 3.98, 6.65, and 9.69%, respectively. Thus the tendency for increased loosening of glassine seals with prolonged storage seems relatively well established.

Although the largest individual percentages of broken seals have been observed from 70°F/80% r.h., followed by the 0°/amb. and 100°/57% conditions, the general temperature effect, if any, remains uncertain. The time effect has applied to each room, with the single exception that the 70°/80% mean was 0.41% higher at 24 than at 36 months.

Packages Torn. There have been no torn packages in biscuit CD2; although all units are packed on edge, the waxed paper has held. The other item in waxed paper, biscuit CD7 with only one-third of the units packed on edge, has averaged 6.2% torn packages (high 11.5% at 24 months), being exceeded only by biscuit CD6 (thin cellophane, 86% of the units on edge), which averaged 16.1%, with a high of 35.1% at 24 months. Among the glassine-wrapped items, no can of wafers has exceeded 1.6% torn packages and the 36 months wafer averages of 0.53 and 0.26% (Table 7) are the highest observed; these items are closely packed and have rounded corners, although 97% of the units are packed on edge. Of the other five glassine-packed items, biscuit CD4 (2½-gal. can, units all on edge) had 7.8% tearing at 36 months, 5.4% for the last three examinations; cracker CD1 (small can, 60% on edge) had 7.2% at 36 months but only 3.1% for 18-36 months, as compared to 4.2% for CD8 (5-gal. can, one-third of packages on edge); CD3 (small can, all on edge) and CD5 (large can, one-third on edge) had 5.9 and 0.7% at 36 months, 2.8 and 1.8% for 18-36 months. Thus the influences of can size and of packing the units on edge instead of flat were not clearly defined by overall percentages, although most of the torn packages were, in fact, those resting on the sharp edges of the units.

The time effect was fairly well established, means for CD1 and CD3-8 at 12, 18, 24 and 36 months being 1.7 ± 2.1%, 2.8 ± 2.4%, 9.4 ± 11.1% and 6.6 ± 4.4%, respectively. High mean values for CD5, 6 and 7 occurred at 24 months, all others (except CD2, no tearing) were at 36 months.

A temperature effect was suggested in that torn packages generally averaged lowest from 40°F and next lowest from 100° (65% of all observations), these being 2.86% for 40° and 4.09% for 100° as compared to 8.88% for 70° and 0° at 24-36 months, excluding CD2. Temperature results were relatively variable, however, so the relationship remains somewhat uncertain.

Total Packages Broken. Total breakage was the sum of broken seals and torn wrappers in CD5, 6, 7 and 10 (with none in CD2). The other five items had "overlap" (packages both unsealed and torn) ranging from 0.07% in CD9 to 4.16% in CD8, average 2.40%. Total breakage averaged .00 and 5.90% for waxed papers (CD2 and 7), 15.77% for cellophane (CD6), 15.87 ± 8.72% for the four cracker items and biscuit CD4 in waxed glassine, and 1.33 ± .27% for the wafers in glassine. Values were less than half those at 24 months for the CD7 waxed paper and CD6 cellophane, but somewhat more than the 12-18 months percentages of broken packages in these items. Breakage of the glassine wraps has increased more or less steadily, previous averages being 0.56, 6.55 and 11.72% at 12, 18, 24 months for the crackers and biscuit CD4, and 0.68 and 1.06% at 12-18 and 24 months for the wafers. Thus there is apparently a time effect on the glassine.

The temperature effect on total packages broken has remained too variable for determining definite trends for the three years of storage.

III.A.1.b. Breakage of Products. (Table 8)

Separation of Score Lines. Breaking apart at score lines was apparently not associated with whether units were baked 2 or 4 per layer, or whether packages were stacked in cans with layers lying flat or standing on edge. There was generally more breaking apart of crackers than of biscuits (see Table 8).

An association of breaking with baking characteristics was suggested; crackers CD1 and CD5 were moderately hard, dark-baked items, hence brittle, and most of the 2-unit layers of CD1 were also slightly concave, causing them to separate with pressure strong enough to flatten out the layers. Crackers CD3 and CD8 and biscuits CD2 and CD7 were moderately baked, and all except CD2 are relatively brittle in texture, but CD8 has higher moisture, hence is apparently less brittle. Biscuit CD2 had tougher texture, and CD7 had lower moisture, causing CD7 to be more brittle. Biscuit CD6 was baked dark and was the hardest and toughest of all the crackers and biscuits--apparently too tough to break apart easily. Biscuit CD4, however, was the lightest-baked and most tender of all the cereal items, so its relatively low percentage of breaking apart seems not to fit

into the pattern, until it is noted that this item had the third highest percentages of moderately and severely broken units--apparently the score lines were less easily broken than were the very light-baked units.

There was no generally significant relation of score-line breakage to storage temperature, although significant ranges were found in crackers CD5 and CD8 and biscuit CD4. The only definite time difference was in cracker CD1, which averaged 9.52 ± .32% higher at 24-36 months than at 12-18 months; the other seven items averaged 0.24 ± 1.87% less at 36 months than at previous examinations.

Chipped or crumbled edges of wafers averaged ca 35 ± 4% for the lighter wafer (CD9) and 39±16 for the darker (CD10), as compared to previous averages of 35 ± 16% for CD9 and 55 ± 21% for CD10. These counts, not included in Table 8, have shown no relationship with anything except can variation, and since the slight crumbling of edges is more irritating than serious, determination of this defect is being discontinued.

Moderate Breakage of Units. Mean breaking of cracker units averaged 16.46 ± .24% for CD1 and CD3 (dark bake, fracture ca 1400 g) and 13.50 ± .45% for CD3 and CD8 (baking moderate, fracture ca 1150 g). Biscuit CD4 (very light, fracture ca 1100 g) averaged 15.07%; the harder and tougher biscuits CD2 and CD4 had only 2.32 ± .40%, while CD7, which had less moisture and more brittleness, averaged 4.82%. Breakage of wafers was very low, averaging only 0.30 ± .06% of the units.

Temperature differences exhibited no consistent pattern, nor was there a consistent time effect. Four items had more breakage at 24-36 months than at 12-18 months, however; these increases were 11.11 ± 1.73% to 15.20 ± 2.16 for cracker CD3, 1.66 ± .03% to 2.15 ± .22% for biscuit CD2, 12.20 ±.93% to 15.05 ± .02% for biscuit CD4, and 0.12 ± .02% to 0.32 ± .08% for wafer CD9. Two items decreased at 24-36 months, from 6.22 ± .44% to 4.84 ± .03% for biscuit CD7 and 0.53 ± .09% to 0.30 ± .06% for wafer CD10.

Crushed Units. As may be seen in Table 8, percentages of crushed or seriously broken units followed the general pattern of score line and moderate unit breakage--crackers and biscuit CD4 had most of the crushed units. There has been no consistent relationship of crushed units with storage temperatures nor with storage time, with the exception that cracker CD1 averaged 1.10 ± .17% at 12-18 months and 0.32 ± .04% at 24-36 months.

While results have been given in terms of percentages of all units in all cans, only ca 52% of the cracker cans, 27% of biscuit cans, and 3% of wafer cans examined from 12-36 months have had

crushed units. In these cans only, extent of crushing averaged 1.66 ± 1.96% for crackers, (CD5, 81% of cans averaging 1.80%; CD3 and CD8, 45% of cans averaging 1.41%; CD1, 35% of cans averaging 1.99%), 1.01 ± 1.02% for biscuits (8% averaging 0.19% in CD2, 25% averaging 1.98% in CD4, 31% averaging 1.07% in CD6, 44% averaging 0.57% in CD7), and 6.03 ± 3.72% for wafers (none in CD9, 6% of cans in CD10). There was again no consistent association with temperature or time of storage.

<u>Total Product Breakage</u>. The total breakage shown in Table 8 is the sum of score line and unit breakage for CD2, 3, 5, 6 and 7, and is merely unit breakage for wafers CD9 and CD10. For CD1, 4 and 8, only half the score-line breakage is included as total, because these are baked in 2-unit layers and thus have only half as many score lines as units.

Results again suggest the influence of item characteristics as discussed above. Crackers CD1, 3 and 5 averaged 31.33 ± 1.56%, while cracker CD8 (higher moisture), biscuit CD4 (light bake but relatively fragile) and biscuit CD7 (lower moisture and more brittleness) averaged 16.93 ± 2.15%. Biscuits CD2 and CD6, with higher fracture strength, averaged 6.10 ± 1.18%, and the compactly-packed wafers had only 0.30 ± .06% breakage. Temperature differences were non-significant, and while ca 2/3 of the higher percentages of breakage were found at the last two examinations, the time effect is far from definite. Crackers and biscuits averaged 18.65% at 12-18 months, 21.52% at 24 months, 19.62% at 36 months; wafers averaged 0.32%, 1.08%, and 0.30% at these respective periods.

III.A.1.a-b.i. Package and Product Breakage in Biscuits from General Services Warehouse. (Tables 7 and 8)

The GSA biscuits, averaging 444 units per 2½-gal. can, were packed in waxed glassine, 2 units per layer, average 13, 14, and 13 X 15 layers in the 15 packages per can. Packages were arranged in 5 tiers of 3 packages each, the tiers alternating with respect to units resting flat or on edge; i.e., 40 to 60% of the units were packed flat (or on edge). Thus the can, and the layer and package arrangement were similar to cracker CD1 and biscuit CD4, the wrapper and general packing were comparable to items CD1, 3, 4, 5 and 8.

Seal breaks averaged 3.33 ± 5.78% (13.3% in 3 cans, none in 9 cans), compared to 10.33 ± 9.34 in the cracker and biscuit glassine wrappers stored at 70°F/57% r.h. Torn packages, however, averaged 47.78 ± 32.98% (range 0-100%) as compared to 6.00 ± 8.00% in the CD packages, so total unsealed packages averaged 48.89 ± 32.93% (2/3 of packages with broken seals were also torn) in the GSA biscuits, 15.67 ± 12.57% in comparable CD items.

The GSA biscuits resembled cracker CD1 and biscuit CD6 in color, being darker than the other biscuits and than crackers CD3 and CD8, but not as dark as cracker CD5. Fracture strength was similar to that of crackers CD1 and CD5, lower than biscuits CD2 and CD6 but higher than biscuits CD4 and CD7 and crackers CD3 and CD8. Moisture content was ca 0.7% lower than that of cracker CD5, 0.9-1.7% below the CD biscuits, and 1.5-2.0% below the other CD crackers, so the GSA product was relatively hard but also quite brittle.

Score line breakage averaged 23.69 ± 20.39% for the GSA biscuits, nearly as much as the ca 25.4% of cracker CD1 but considerably above the other crackers (12.53 ± 4.18%) and the CD biscuits (5.48 ± 3.28%). Moderate unit breakage was 12.46 ± 7.16%, also above the 5.23 ± 3.43% of the CD biscuits and the ca 10.7% of cracker CD5, but below the 16.17 ± 2.54% of the other CD crackers. Crushed GSA biscuits averaged 7.56 ± 11.26% (6 cans had none, others ranged 1.8-35.1%), much higher than the 0.50 ± .22% of the CD crackers and biscuit CD7 (CD2, 4, 6 had none at 70°F). Total breakage of the GSA biscuits was 31.87 ± 25.26%, similar to that of cracker CD1 and below the ca 38% of cracker CD3, but higher than the 19.35 ± 1.85 of crackers CD5 and 8 and much higher than the 10.50 ± 4.61% breakage in the CD biscuits.

It may be noted in Table 8 that differences between the two cases of the GSA biscuits were larger than differences among the six cans per case; one case had apparently been handled more roughly than the other.

III.A.2.a. Sensory Scores for Appearance and Color. (Table 9)

Appearance and color scores have varied, but there has been very little overall change in storage means--the 10-item mean of 7.32 at 36 months is almost the same as the initial mean of 7.34. Items CD1, 3, 6, 8, 10 were scored lower initially (6.76 ± .23); at 36 months, these averaged 0.50 ± .38 above initial and only 0.11 ± .15 below the highest scores received in storage. Items CD2, 4, 5, 7, 9 averaged 7.91 ± .31 on initial scores; at 36 months the average was 0.54 ± .26 below initial and 0.26 ± .22 below the highest storage scores. Thus, since initial means of the two groups differed by 1.15 and the current group difference is only 0.11, with general mean the same as initial, the only general time effect seems to be an equalization of score levels used by the judges for the various items.

Temperature changes have been somewhat more definite, in response to a general tendency for fading (and in wafers an eventual slight browning) of samples at 100°F and, in some instances, a perceptible dulling of 40°F samples. Most of the judges considered

the fading at 100° an improvement at 6 months, with the result that average scores were 7.42 at 100°, 7.31 at 70°, 7.20 at 40°, and 7.26 at 0° for that examination. As fading and slight glazing became more pronounced, the 100° scores were reduced; averages for 12-36 months were 7.05 at 100°, 7.15 at 70°, 7.13 at 40°, and 7.20 at 0°. Even after 36 months, however, the 100° samples of cracker CD1 and biscuit CD6, both darker items, were scored higher than were those from 0°, and the 40° and 0° samples of the light biscuit CD4, were termed "duller" than those from 70° and 100°.

III.A.2.b. Hunter Color Values. (Table 10)

Hunter L Values. The general fading and glazing effects of higher temperatures are seen in the higher L values of Table 10. This temperature effect has been relatively consistent over the three years of storage, mean increases per examination period from initial to 36 months being 1.11 ± .71 for crackers and biscuits and 0.68 ± .68 for wafers at 100°F, 0.86 ± .20 for all products at 70°, and 0.51 ± .60 for all products at 40° and 0°. Periods of greatest increase ranged from 6-12 months for crackers and biscuits at 70° and wafers at 0° to 24-36 months for wafers at 70°, most of the maximum increases coming at 12-18 months. Highest values were observed at 24 months in crackers CD5 and CD8, biscuit CD7 and wafer CD9; all other items reached highest mean values at 36 months.

The smaller increase in mean L value for wafers at 100° apparently resulted from a tendency for some samples to darken slightly with prolonged storage, but variability within samples of the wafers prevents a definite conclusion at this period. The average extent of fading or glazing was greater for the darker wafer (CD10, average 3.92) than for the lighter (CD9, average 3.30), and for the darkest biscuit (CD6, average 5.28) than for the lightest (CD4, average 3.67). This did not apply uniformly to the other biscuits or to the crackers, however, as these six items averaged 4.39 ± .49 without relationship to lightness of darkenss of baking.

Hunter "a" Values. With the exception that cracker CD5, the "reddest" of all the cereal items, tended to decrease less in "a" or redness at higher temperatures and increase more at lower temperatures than did other items, the degree of baking was apparently not associated with either fading or increasing of the red color component. Temperature differences were fairly definite at 100° and 70°F, less so at 40° and 0°.

The extent of fading of "a", and something of the relationship of fading to "glazing", which apparently was the main factor in increasing the L values as noted above, may be estimated as follows:

At 100°F, crackers and biscuits stored three years averaged 0.84 ± .48 below initial; minimum values for these products averaged 1.27 ± .30 below initial, at periods averaging 11 ± 5 months for cracker CD5 and biscuits CD4, 6 and 7 and 33 ± 6 months for crackers CD1, 3, 8 and biscuit CD2. Wafer CD9 was above initial at every examination, average increase being 0.54, with lowest values at 12 and 18 months. Wafer CD10 averaged 0.20 below initial at 36 months, lowest values at 24 and 36 months. Thus it appears that items CD5; CD4, 6, 7; and CD9 were browning to some extent at 100°, and that continued increases in L values through 24 months for CD5, 7, 9 and 36 months for CD4, 6 were due almost entirely to glazing of the surfaces.

At 70°F, the 36-months "a" values for crackers and biscuits were 0.44 ± .31 below initial, wafers averaged 0.23 ± .08 below. Minimum values averaged 0.84 ± .35 below initial, at 30 ± 12 months for CD1, 3 and 2, 4, 6 but 13 ± 7 months for CD5, 8 and CD7. Thus the latter three items were apparently browning at 70°, with continued increases in L values due primarily to glazing. The wafers averaged above initial "a" values for the three year period, but were below initial at 36 months.

Results were variable at 40° ar.. °F. At 40°, cracker CD8 and biscuits CD2, 6 and 7 averaged 0.3[illegible] ± .09 below initial "a" values after three years (CD8 and CD7 averaged 0.36 below for all examinations) but the other crackers and biscuit CD4 were 0.53 ± .29 above initial, and the wafers were 0.30 ± .10 above. Maximum increases of 0.85 ± .05 for wafers and 0.68 ± .16 for crackers and biscuits were attained at 12 ± 6 months for crackers CD5 and 8 and biscuits CD2 and 4 and 24 ± 6 months for other items. Thus some fading with prolonged storage is suggested for CD8, 2, 6 and 7, and possibly for CD5 and 4, but not for the other four items.

At 0°, cracker CD8 was 0.4 below initial and biscuits CD2 and 6 were the same as initial after three years; other crackers and biscuits were 0.48 ± .34 above, and maximum values for the eight items averaged 0.85 ± .26 increase, at 18 ± 3 months for all except CD5. Wafers averaged 0.20 ± .05 increase at 36 months, 1.05 ± .05 maximum increase at 21 ± 3 months. Thus practically all of the increase in L values at the lower temperatures was apparently due to surface "glazing", as very little fading of red can be demonstrated except possibly in CD4.

<u>Hunter "b" Values</u>. In evaluating the results of Hunter Color readings, it was noted that "b" values for cracker CD3 and biscuit CD4 were higher than any previous reading for these items, even thou

samples for both came from the same cases of $2\frac{1}{2}$-gal. cans which had been sampled at 18 and 24 months. Investigation revealed a "b" mirror on the Hunter instrument which sometimes stuck when standardizing, suggesting that the CD3 and CD4 readings could be too high, CD3 by ca 1.0 and CD4 by ca 2.0. If so, the general mean of Table10 would be 21.98, which is the same as initial and the mean of 6, 18 and 24 months readings, although 12 months values averaged 22.34. Regardless of whether the CD3 and CD4 readings were incorrect, the general trend for "b" readings has exhibited no major changes except a tendency toward slightly higher values at higher temperatures. This is in line with the fading noted at 100° and 70°F; no significant decreases in "b", such as would be expected with serious degrees of browning, have been observed, although slight browning has been noted in various samples.

Hunter a/b Ratios. As the predominant color changes of crackers and biscuits have been fading at higher temperatures, a/b ratios have followed the pattern of changes in "a" or red component; i.e., considerable decreases at 100°F, lesser decreases at 70°, slight increases at 40° and moderate increases at 0°. The time effect is indefinite, as the primary change associated with time was increased glazing of surfaces.

GSA biscuit readings are appended to Table 10. The visual relationships to the color of other biscuits and crackers were noted on page 19 (above).

III.A.3. Fracture Strength. (Table 11)

There seems to be very little if any significance in fracture strength variations except among groups of items. For all samples examined, CD3 and 4 averaged 1083g, CD7 and 8 averaged 1173g, CD1, 5 and 10 averaged 1454g, and CD2, CD6 and CD9 averaged 1637, 1852, and 2200g, respectively. Initial average was 1415g, 6-12 months average 1440g, 18-24 months average 1468g, 36 months average was 1506g; the 100°F and 70°/80% samples averaged 1447g, 70°/57% and 0° samples 1474g, and the 40°/57% samples 1497g. Differences as small as these are of little practical significance, considering the wide range among the ten items. They have, however, been relatively consistent; i.e., there has been a recognizable trend for one or both of the 100°F readings to be somewhat lower than one or both of the readings on 70° samples, and for the 40° values to be higher than those from 0°.

As seen in Table 11 and noted above (p.19), the GSA biscuits were near "average" in fracture strength, ca 1400g.

III.A.4.a. Residual Oxygen in Cans. (Table 12)

Due to leaking cans, the oxygen content of can atmospheres of biscuit CD4 averaged 19.7 ± .7% for the six examinations from initial to 36 months. Other items varied as received, initial averages being 16.8% for wafers, 17.8% for biscuit CD6, 19.5% for crackers CD1 and CD5, and 20.3% for biscuits CD2 and 7 and crackers CD3 and 8. Decreases have been generally proportional to time, temperature, and also to magnitude of initial decrease except in CD1 and 3. Values apparently approached equilibrium lows, however, at ca 18 months for wafer CD9 and 24 months for other items except CD2 and CD5, which reached low averages at 36 months.

Excluding item CD4, low averages and 36 months averages, respectively, for the nine sealed items are: 6.2% (av. 23 months) and 9.3% from 100°F storage, 12.0% (av. 26 months) and 13.8% from 70°, 15.4% (av. 29 months) and 15.9% from 40°, and 17.8% (av. 27 months) and 18.5% from 0°. The occurrence of low values at periods before 36 months in 35 of the 54 samples was apparently due to can variations, including possible errors in readings, under near-equilibrium conditions. Levels attained by each item at 36 months are shown in Table 12. The GSA biscuits were comparable to biscuits CD2 and CD7 at the 70° conditions.

III.A.4.b. Moisture Content. (Table 12)

Moisture contents apparently vary only by items, as no consistent association with either temperature or time of storage has been observed. The correlations of higher moisture with lower fracture strength in crackers (-.503 at both 24 and 36 months) and with higher fracture strength in biscuits (+.609 at 18 mo., +.545 at 24 mo., +.650 at 36 mo.) were maintained, but no such relationship as was calculated at 18 months (+.794) and 24 months (+.633) was found in the wafers.

As noted above (p.19), the GSA biscuits had considerably less moisture (1.12%) than any of the other CD products, which ranged 1.62 to 3.59, average 2.71%.

III.A.4.c. Rancidity Values of Fat from Rations. (Table 13)

Peroxide Values. Mean levels of peroxides for 12-36 months of storage were:

Months	100°F P.V.	70°F P.V.	40°F P.V.	0°F P.V.
12	13.26	3.84	1.68	1.41
18-24	1.08	.50	.20	.11
36	1.54	.99	.35	.25

Products 36 months	100°F P.V.	70°F P.V.	40°F P.V.	0°F P.V.
crackers	2.29 ± 1.10	1.86 ± .83	.47 ± .43	.24 ± .16
biscuits	1.55 ± .87	.54 ± .20	.27 ± .10	.26 ± .09
wafers	.16 ± .12	.15 ± .15	.27 ± .12	.25 ± .13

These values correspond very well with sensory ratings for the various items, and are typical of "equilibrium" conditions such as have apparently been established in most of the cans. Values for crackers and biscuits are higher than those at 24 months, and with the relatively static headspace oxygen pattern, it is probable that some of the peroxidation occurred _after_ the cans were opened for sampling and fresh air supplies were thus made available to flush away reaction gases which had accumulated in the sealed spaces. Wafers, however, had lower values than at 24 months in the 70°F and lower conditions, indicating more advanced stages of oxidation (beyond the early or peroxidation phases) during the third year and at least corresponding to the tendency for the lower-temperature samples to score lower than those from 100°.

Free fatty acids. The relatively sharp increase in free fatty acids at 100°F, as compared to 100° levels at 18 and 24 months, furnishes part of the basis for the suggestion that increases in peroxides in the higher-temperature samples may have taken place after the cans were opened. Free fatty acids tend to increase under conditions which retard peroxidation; in active oxidation systems, free acids usually decrease, as they are more readily oxidized than are intact fats. Thus accumulation of mixtures of various reaction gases and water vapor, with reduced oxygen tension in the headspaces, would be expected to favor hydrolysis and depress further peroxidation while the cans remained sealed.

During the third year, increases in free fatty acids for all items averaged .098%, and the 36-months average was .089% above the combined previous average for all items except CD6, which remained below initial. By storage conditions, compared to previous high values, these increases averaged .184% at 100°F, .010 at 70° and 40°, none at 0°. Thus the increase was practically all at 100°; 3-year values at this temperature ranged from .160 to .850%, with an average of .514% as compared to initial average of .280%. The mean differences between 100° and the lower temperatures at each examination period from 6 through 36 months were .026, .046, .057, .101, and .231%. It thus becomes apparent that none of the items were designed for prolonged storage at 100°--even biscuit CD6 was up ca .04%, though averaging ca .03% below initial at other conditions.

As noted in Table 13, peroxide values of the GSA biscuits were lower (0.25) than those of the CD biscuits or crackers; free fatty acids (0.26) were higher than those of biscuits CD2 and CD6 and crackers CD1 and CD5, but lower than the other six CD items. The GSA product was not described as rancid or particularly stale by the score panels.

III.A.5.a. Sensory Scores for Texture, Aroma and Flavor. (Tables 9 & 14)

Texture scores have varied quite a bit for the darker items such as crackers CD1 and CD5, biscuit CD6, and the wafers, as these were more unevenly baked than were the lighter products. There has been no serious decrease in the scores, but a tendency toward extra brittleness has been noted in samples from higher temperatures, beginning at 12 months. Differences between 100°F samples and those from 70° increased from .05 at 12 months to .43 at 36 months (.54 if wafers are omitted), while products from 40° and 0° were rated above 100° samples by average differences increasing from .24 at 12 months to .54 (.62 without wafers) at three years. This trend may be observed in the texture scores of Table 9.

The levels to which aroma and flavor scores have been reduced by storage at higher temperatures is shown in Table 14. These represent the following decreases from initial or (in items with low initial scores) previous high scores:

	Crackers		Biscuits		Wafers	
	aroma	flavor	aroma	flavor	aroma	flavor
100°F	2.90 ±.46	2.49 ±.55	2.79 ±.66	2.79 ±1.14	1.08 ±.39	.38 ±.05
70°F	.71 ±.37	.38 ±.27	1.18 ±.42	1.29 ± .64	1.30 ±.20	.73 ±.20
40°&0°F	.14 ±.29	.20 ±.16	.38 ±.67	.41 ± .44	.68 ±.19	.03 ±.26

The greatest decreases in aroma scores were noted at the second year from both 100° and 70° storage. The flavor of 100° samples also decreases most during the fourth 6-month period, but the slight decreases in flavor from 70° storage were gradual and relatively variable. The smaller decreases in wafer scores resulted from lower initial scores and higher 36-months scores than those for crackers and biscuits; it is seen that wafers from 70° were scored no higher than those from 100° after three years.

The judges on the sensory evaluation panel considered all of the 100° crackers, and biscuits CD2 and CD7 from 100° storage, to be definitely borderline in acceptability at 36 months.

III.A.5.b. Hedonic Ratings for Aroma, Flavor and Palatability. (Table 15)

At 36 months, mean decreases from previous highs for hedonic ratings were as follows:

	Crackers		Biscuits		Wafers	
	aroma & flavor	palatability	aroma & flavor	palatability	aroma & flavor	palatability
100°F	1.73 ±.24	1.18 ±.26	1.74 ±.33	1.31 ±.15	.13 ±.10	.10 ±.09
70°F	.26 ±.29	.30 ±.20	.65 ±.27	.75 ±.12	.46 ±.15	.22 ±.13
40°&0°F	.19 ±.15	.28 ±.19	.48 ±.26	.55 ±.17	-.16 ±.20*	-.26 ±.06

*Ratings averaged higher than at any previous examination.

Reference to Table 15 will show that a few of the cracker samples from 100°F were at the borderline (4.00) on aroma and flavor, but all palatability ratings were acceptable by this criterion. The periods of greatest changes in ratings averaged 18-24 months for crackers and biscuits, 6-18 months for wafers at 100°F; 12-18 months for crackers and 18-24 months for biscuits and wafers at 70°; and 12-18 months for crackers and 24-36 months for biscuits and wafers at 40° and 0°. These corresponded relatively well with periods following peaks in peroxide values at higher temperatures or "breaks" in peroxide levels at 40° and 0°; i.e., with expected oxidation patterns in the sealed cans.

As seen in Table 9, the GSA biscuits scored about average on texture (7.28). On aroma and flavor, however, (Table 14), the GSA product was comparable to biscuit CD2 but above other CD items except cracker CD1 on aroma (6.58), and above all items except biscuit CD6 on flavor (6.80). Hedonic ratings were also comparatively high; as given in Table 15, aroma rated 6.31, flavor 6.53, palatability 6.57, in each instance higher than the other CD items except biscuit CD2. In general, the product from the General Services warehouse was in good condition after 3½ years of common storage.

III.A.5.c. Correlations of Palatability Ratings with Other Measurements. (Table 16)

The correlations shown in Table 16 are somewhat "out of context" when observed as a single set of values; i.e., the actual meaning of the correlations can be interpreted only in relation to time, temperature, and the various characteristics of the individual items. As each additional examination contributes to the evaluation of these relationships, the detailed interpretation will be discussed in the final report of the current study.

In general, the correlations with Hunter Color values have depended on the fact that the predominant color change has been fading at higher temperatures, which have also been associated with reductions in palatability ratings. Thus correlations with Hunter "L" and "b" are generally negative, as these values tend to increase with fading and surface glazing, while those with Hunter "a" and a/b are positive, since red and red/yellow values remain higher in the non-faded or lower-temperature samples. Note, however, the switch in the "all" biscuit correlations--the panel members, while scoring lighter within-item samples down because of temperature effect, still tend to prefer the lighter items within product types.

Correlation with fracture strength and moisture content have varied considerably, there being some suggestion of higher fracture at lower temperatures, but no consistent pattern with moisture content. Oxygen content and rancidity values obviously and expectedly follow temperature and time effects, and agreement of sensory quality scores with hedonic ratings has increased steadily in crackers and biscuits, though not in the less typical wafers.

B. Carbohydrate Supplements

The hard candy items were examined after 18 and 24 months in the period covered by this report, and data in Tables 17-26 include both examinations. Most of the discussion below will emphasize the condition of the product after 24 months.

III.B.1.a. Condition of Packages

Measurements of internal size and length of top lips of candy bags were discontinued after 12 months. Counts of usable bags per can and measurements and testing of bag seams are being continued.

The cumulative numbers of usable bags through the 24-months examinations were as follows:

Usable bags per can	Percentage of Cans			
	CD11	CD12	CD13	Mean
21	3.7	7.4	7.4	6.2
20	86.9	66.5	87.0	80.2
19	5.6	11.1	5.6	7.4
18	-	5.6	-	1.9
17,16,15 (1 ea.)	1.9	3.7	-	1.9
11	-	3.7	-	1.2
none	1.9	1.9	-	1.2

All cans except those (2) with none had 19 or more bags; the (8) cans listed with 17, 16, 15 or 11 usable bags had 3, 4, 5 or 9 bags with only one extra-wide seam.

Seam widths vary considerably from the "normal" $\frac{1}{4}$-inch. Cumulative data through 24 months were as follows:

Seam Width 16ths inch	Percentage of Seams			
	CD11	CD12	CD13	Mean
09-16	-	3.5	1.4	1.6
08	-	1.0	9.1	3.4
07	1.1	1.6	9.3	4.0
06	17.5	11.7	10.9	13.3
05	-	1.1	-	.4
04	69.0	73.3	67.8	70.0
03	3.9	3.7	.4	2.7
02	7.5	.7	1.1	3.1
01	1.0	2.0	-	1.0
00	-	1.4	-	.5

Seam test results, by periods, are given in Table 17. While the results were extremely variable, there are suggestions that numbers of seams separating, linear extent of separation, and number of seams pulling completely apart (CD13 bags only) are all increasing slightly with time in storage. There appears to have been no consistent association of seam failure with storage temperatures or with leaking cans during the first two years of storage.

III.B.1.b. Condition of Candy. (Table 18)

Total counts of yellow and red pieces, unsanded pieces, and off-color and off-shape pieces were discontinued after the first year, as these are formulation and packing variables not influenced by storage. Determinations of clumped pieces, chipped and broken pieces, and of loose sugar and bits of candy which passed an 8-mesh screen are given in Table 18.

Clumping or pieces stuck together has been somewhat variable in CD11, including some association with leaking cans but no consistent association with storage conditions. Period means for CD11 ranged ca 1.2-2.4%, as compared to 0.08-0.13% range for clumping in CD12 and 0.24-0.46% in CD13.

Breakage of pieces has also been variable, with no apparent association with any storage factor. Periodic means for the three items ranged 1.5-4.9%, 3.3-24.3%, and 3.9-7.7% for chipped pieces,

and 0.24-2.65%, -0.60-0.25%, and 0.36-3.03% for broken pieces in excess of chips from the chipped candy. Several cans of CD12 had fewer broken bits than the amount required to restore the chipped pieces to normal weight, indicating chips lost before the candy was packed in the cans.

Loose sanding sugar and bits of candy passing 8-mesh screen ranged, by periodic means, 2.4-3.6% for CD11, 0.43-0.66% for CD12, 0.36-1.08% for CD13; again there was no apparent association with any storage variable.

III.B.2.a. Sensory Quality Scores, Appearance and Color. (Table 19)

The general means for appearance-color scores have varied relatively little, averaging 7.66 ± .13 for the four examination periods. As the candies tended to darken and appear slightly glazed at higher temperatures, the 100°F and 70°F samples were consistently scored lower than those from 40° and 0°, but the reductions of 100° and 70° scores were partially compensated by increases in scores for the lower temperatures. Maximum temperature differences were 1.50 at 100° after 18 months and 0.48 at 70° after 24 months; mean differences were 0.99 for 100° and 0.30 for 70° at these periods. In general, color and appearance were not seriously affected by two years of storage even at 100°.

III.B.2.b. Hunter Color Values. (Table 20 and 21)

The Hunter values for the lemon or yellow candies exhibited no consistent pattern of change, as the variations among cans and cases were quite large (Table 20). Visual inspection of the 100° and 70°F samples revealed noticeable variations in "darkness" or dullness among individual pieces, but some of these were also observed in lemon candy from lower temperatures--the only indication of a trend was the slightly lower "b" values at 24 months.

The cherry or red candies were also quite variable (Table 21), and most cans of CD11 and CD12 at 24 months had slightly redder pieces than at 18 months. There was, however, a very moderate but fairly consistent darkening in the 100°F samples of CD12 and CD13, which is illustrated by the decreases in the "b" or yellow component of color. In general, color changes in either type of carbohydrate supplement have been considerably less than the differences among replicate cans.

III.B.3. Fracture Strength - Not applicable to candies.

III.B.4.a. Residual Oxygen in Cans - Not determined in candies.

III.B.4.b. Moisture Content. (Table 22)

The mean moisture content for the three supplements when sampled initially, as average of item means, was 1.40 ± .08%. Storage means on the same item basis were 1.77 ± .15 for 6 and 12 months, 1.41 ± .19 for 18 and 24 months. As standard deviations of rooms within items and of cans within rooms were ± .18 and ± .17 at 6-12 months, ± .16 and ± .11 at 18-24 months, the 6-12 months moisture values were definitely higher than initial and 18-24 months values; the cause of the increase at 6-12 months has not been determined.

Only two apparent differences associated with storage conditions have been observed. One is a general tendency for moisture from 0°F samples to be higher than that from other rooms. By items, this increase averaged 0.24 ± .26% for CD11 (2 of 20 comparisons were higher than 0°), 0.09 ± .09% for CD12 (3 of 20 comparisons higher than 0°) and 0.04 ± .09 for CD13 (6 of 20 comparisons higher than 0°), so the trend was not absolutely definite. The second difference was an apparent reduction of moisture in the 100°F samples of CD12. This reduction averaged 0.14 ± .05 (100° samples lower in 30 of 32 comparisons), so was relatively definite, but did not apply to items CD11 or CD13.

The only other difference observed in moisture was between yellow and red types in item CD13. Of 52 cans examined in this item, yellow averaged 0.38 ± .17 higher than red in 36 cans, red 0.17 ± .09 higher in 16 cans. Thus most of CD13 red was apparently less hygroscopic than the yellow, possibly as a result of slightly higher end-point temperature in cooking the red candy.

III.B.4.c. Rancidity Values - Not applicable to candies.

III.B.4.d. pH Values. (Table 22)

As with moisture, pH values were also higher at 6-12 months than the initial and 18-24 months values, and again the cause of the first-year increase has not been determined, although a meter error was suspected. Data in Table 22, as room averages and can differences, show that there were two cases, or four cans, of CD11 with pH averaging 0.71 ± .04 lower than the other eight cans of this item at 24 months. Using the "normal" average of 6.48 for these low cans, periodic mean pH values, by items, were 6.67 ± .09 for initial, 6.94 ± .09 at 6-12 months, 6.70 ± .10 at 18 months, and 6.56 ± .08 at 24 months.

As determined, CD13 averaged 0.25 ± .15 higher than CD11 and 0.08 ± .06 higher than CD12. Samples from 0°F averaged 0.22 ± .24 (16 of 20 comparisons) higher than other samples in CD11, 0.08 ± .08 (18 of 20 comparisons) higher in CD12, and 0.06 ± .08 (14 of 20 comparisons) higher in CD13, the differences being largely in lower 100° values (0.15 ± .14) with the exception of the low values in CD11 (70°/57% and 40°/57%) at 24 months. The only color-connected pH difference was in CD12, in which the yellow candy averaged 0.18 ± .12 higher than the red in 34 of the 52 cans which have been examined (the other 18 cans averaging 0.04 ± .04 higher red).

Correlations of pH with moisture were +.735 for yellow candies and +.722 for red candies (although CD13 red had a negative correlation). These include the highest or second highest positive correlations during the two years of storage for CD11 and CD12, but CD13 yellow has been quite variable and CD13 red has changed more or less progressively from +.426 at 6 months to -.633 at 24 months. This negativity resulted from higher pH with lower moisture; the reverse, or lower pH with higher moisture, which would be expected to result in hydrolysis of sucrose, has not been observed to any serious extent except in the low-pH cans of CD11 at 24 months.

III.B.4.e. Sugar Contents. (Table 23)

As with most of the other values determined in the candies, sugar contents were characterized mainly by their variability, which was greater at 24 months than at other periods in all parameters except dextrose in CD12. There was no definite temperature pattern, although dextrose in samples of CD11 from 100°/80% was somewhat higher at 18 and 24 months. An apparent time change, involving higher dextrose and lower sucrose in CD11 and CD13 at 18 and 24 months, resulted largely from the occurrence of certain "odd" samples, particularly in CD11.

Examples of the "odd" samples were as follows: at 18 months, both cans of CD11 from 100°/80% were low in Hunter L, and in "b" for yellow candy only, and more positive in Hunter "a" and a/b (i.e., the yellow candies had less green and the red candies more red); pH was normal, moisture low, yet dextrose was high and both sucrose and total sugar low in candies of both colors. This could have been a temperature or a formulation effect. At 24 months, both cans of CD11 from 100°/80% were also high in dextrose and low in sucrose, but all other parameters were normal. Also at 24 months, candies CD13 from 40°/57% were high in dextrose and low in both sucrose and total sugar, with everything else within normal ranges. Finally, the "oddest" samples encountered were all four cans and both types of candies (lemon and cherry) of CD11 from 70°/57% and 40°/57% at 24 months. These had normal color, but were unusually high in dextrose

and low in sucrose and total sugar (Table 23), and also unusually low in pH and moisture. The "off-normal" sugars could have resulted from hydrolysis at the unusually low pH, but formulation variations seem a strong probability in all of the "odd" samples.

In view of the fact that hydrolysis of sugars should be associated with low pH and high moisture (as well as with high temperatures, which apparently had no consistent influence), correlations of pH with moisture and of both values with the various sugar measurements were investigated. As noted above in the comments on pH, there were no significant combinations of low pH with high moisture; all candies had correlations of high pH with high moisture except CD13 red, which had high pH with low moisture. Thus pH-moisture relationships were not such as would be expected to stimulate hydrolysis of sugars.

Relationships of pH and moisture, considered separately, with sugar values were as follows: Lower pH was significantly correlated with higher dextrose, lower sucrose, and higher dextrose/sucrose ratios within the three items, mostly CD11. Eliminating the eight low-pH samples and sub-samples of CD11, however, reversed the trend to an extent sufficient to afford a by-items correlation of higher pH with higher dextrose and lower sucrose. This tends to confirm the assumption that "odd" samples rather than trends were chiefly characteristic of the sugar values.

With respect to moisture, the correlation of low moisture with high dextrose and low sucrose and total sugar was due largely to CD11 "odd" samples; eliminating these again reversed the trend (to higher moisture with higher dextrose and lower sucrose) in a few instances, but largely eliminated significant correlations of any type. Thus there seems to have been no consistent association of pH or moisture values with sugar values, except in some of the off-formula samples, in the first two years of storage.

III.B.5.a. Sensory Scores for Texture, Aroma and Flavor. (Tables 19 and 24)

While three texture "defects" have been noted with sufficient frequency to assume their reality, none of the texture scores (Table 19) have exhibited any consistent association with storage time or temperature. Overall averages are 7.69 for CD11, 7.80 for CD12 and CD13. The "defects" noted were a few pieces (mostly at 6 and 12 months in high temperatures) which seemed to have a less-hard surface shell, various samples in which candies seemed excessively brittle (again mostly at higher temperatures), and some cans in which the candies seemed excessively "tough", these mostly at lower temperatures. None of these has occurred with sufficient consistency for statistical significance at any condition of storage.

Both aroma and flavor scores decreased with storage at 100° and 70°F (Table 24). For aroma, initial average by items was 7.57 ± .19; the 18-24 months average at 40° and 0°F was 7.51 ± .10, or essentially no decrease. Scores for aroma of 70° samples averaged 0.29 ± .23 below 40°-0° scores at 6-18 months, 0.53 ± .28 below at 24 months. The aroma scores for 100° samples were 0.75 ± .36 below 40°-0° scores at 6-18 months and 0.93 ± .07 below at 24 months. Decreases were ascribed to loss of typical aroma and eventual development of off or "terpene" aroma, particularly at 100°F.

The initial average for flavor, 7.70 ± .27, was almost the same as the 18-24 months flavor average of 7.72 ± .30 for 40°-0° samples. Scores for 70° samples averaged lower than those for 40°-0° samples by 0.30 ± .30 at 6-18 months and 0.32 ± .21 at 24 months; i.e., the 70° samples averaged lower than initial, but changed very little in flavor from 6 to 24 months. Samples from 100° averaged below 40°-0° samples by 0.78 ± .29 at 6-18 months and 0.88 ± .19 at 24 months, indicating a moderate time effect. Flavor was scored down largely from "flatness", with slight "terpene" off flavor during the second year of storage at 100°F.

III.B.5.b. Hedonic Ratings for Aroma, Flavor and Palatability. (Table 25)

The hedonic panels rated practically no difference between flavor and palatability (as seen in Table 25), so the hedonic ratings may be evaluated as aroma and flavor-palatability. Initial averages by items were 6.89 ± .12 for aroma and 7.57 ± .21 for flavor and palatability.

The 40°-0°F average rating for aroma, by items, at 18-24 months was 6.78 ± .17, or only slightly less than initial. Compared to the 40°-0° ratings, aroma for 70° samples averaged 0.04 ± .07 less at 6-18 months and 0.19 ± .01 less at 24 months; aroma for 100° candies averaged 0.21 ± .17 less than 40°-0° candies at 6-18 months, 0.54 ± .21 less at 24 months.

Flavor and palatability averaged 6.98 ± .14 from 40°-0°F at 18-24 months. The samples from 70° averaged the same (±.09) as the 40°-0° samples at 6-18 months, 0.15 ± .05 less at 24 months. Candies from 100° were rated 0.14 ± .23 below 40°-0° candies at 6-18 months, 0.43 ± .17 below at 24 months. Thus the greatest change in flavor and palatability ratings was the drop from initial; apparently the "novelty" wore off with repeated scoring of this product and the ratings dropped more for this reason than for the slight off flavors which were noted in 100°F samples.

III.B.5.c. Correlations of Palatability Ratings With Other Measurements. (Table 26)

The correlations given in Table 26 are for the 24-months examinations, as correlations before this period were practically meaningless. As seen from the present coefficients, there is still relatively little significant relationship between palatability and other measurements except the sensory quality scores. In other words, the temperature differences have become definite enough on aroma and flavor for the examining panel and the hedonic panel to agree, at least on CD11 and CD12, to a significant extent.

The only other significant correlations are with Hunter L on red candies in general and a/b on red CD12, and with moisture content of CD12. The panel preferred the lighter or more glossy CD12 over the darker or duller CD13 and CD11. The preference for higher-moisture samples of CD12 apparently resulted from the fact that the 70°F and lower candies of this item happened to average 0.32 ± .02% higher in moisture than did the 100° samples.

In general, the candies have changed relatively little with storage, so the predominant lack of correlations with palatability ratings is not surprising.

APPENDIX

TABLES 1 THRU 26

TABLE 1

BURSTING STRENGTH OF V3c FIBERBOARD
(pounds per square inch)

A. Bakery Items

Condition °F/% r.h.	CD1	CD3	CD4	CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean	Std.dev. 10 reps
100/80	395	328	391	352	371	403	397	484	349	356	383	25
100/57	348	354	403	379	375	398	410	462	338	349	382	27
70/80	437	436	535	437	416	455	487	532	407	367	451	37
70/57[a]	509	441	509	492	395	460	488	551	462	424	473	39
40/57	509	496	521	531	445	471	547	594	492	505	511	40
0/amb	545	496	612	539	385	481	532	625	499	517	523	42
std.dev.,10 reps	41	26	39	35	36	40	32	34	37	36	35	–
sign.dif., 5%	37	24	35	31	32	36	29	31	33	32	12	36[b]
mean, 36 mo.	457	425	495	455	398	444	477	541	424	419	454	16[c]

B. Carbohydrate Supplements

Condition °F/% r.h.	CD11	CD12	CD13	Mean	Std.dev. 10 reps	CD11	CD12	CD13	Mean	Std.dev. 10 reps
	18 months:					24 months:				
100/80	491	371	378	413	36	474	335	377	395	26
100/57	388[d]	334	403	375	27	487	327	375	396	27
70/80	422[d]	416	418	419	34	495	410	421	442	38
70/57	568	392	464	475	39	531	370	448	450	45
40/57	603	397	446	482	66	574	364	414	451	52
0/amb	477[d]	386	414	426	27	581	443	425	483	65
std.dev.,10 reps	52	37	29	40	–	69	21	28	45	–
sign.dif., 5%	47	33	26	26	41[b]	62	19	26	25	43[b]
Mean	492	383	420	432	19[c]	524	375	410	436	18[c]

[a] GSA biscuit cases (p.5) averaged 479 psig, case difference 8, rep deviation 31.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.
[d] Different manufacturer's case code.

TABLE 2

MOISTURE CONTENT OF V3c FIBERBOARD
(percent)

A. Bakery Items

Condition °F/% r.h.	CD1	CD3	CD4	CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean
100/80	8.7	8.7	8.6	8.5	8.9	8.6	8.8	8.6	8.6	8.6	8.69
100/57	7.2	7.1	7.1	6.8	7.2	6.6	6.9	6.9	6.9	6.9	6.96
70/80	11.5	11.7	11.6	11.5	11.5	11.5	12.0	11.8	11.4	11.5	11.61
70/57[a]	8.5	8.4	8.1	7.8	8.0	8.2	8.1	7.9	8.2	8.2	8.14
40/57	9.9	9.8	9.6	9.3	9.6	8.4	8.9	8.6	8.7	8.6	9.15
0/amb	12.1	12.5	12.2	12.6	12.3	12.0	12.5	12.2	12.2	11.8	12.23
std.dev., 2 reps	.03	.07	.11	.09	.05	.05	.06	.07	.05	.05	.07
sign.dif., 5%	.16	.16	.26	.20	.11	.12	.13	.17	.12	.11	.16
mean, 16 mo.[b]	9.63	9.72	9.53	9.44	9.58	9.22	9.54	9.32	9.34	9.27	9.46

B. Carbohydrate Supplements

Condition °F/% r.h.	CD11	CD12	CD13	Mean	CD11	CD12	CD13	Mean
	18 months:				24 months:			
100/80	9.1	8.5	8.7	8.76	9.2	8.5	8.6	8.77
100/57	7.9	7.4	7.6	7.59	7.6	6.8	7.0	7.15
70/80	10.8	10.7	10.6	10.68	10.9	10.5	10.6	10.64
70/57	8.7	8.2	8.1	8.36	8.1	8.0	7.9	8.00
40/57	8.8	9.2	8.6	8.86	9.3	8.8	8.8	8.96
0/amb	12.2	11.4	11.6	11.73	12.7	12.0	11.3	11.99
std.dev., 2 reps	.09	.07	.07	.08	.05	.06	.05	.05
sign.dif., 5%	.22	.16	.16	.23	.11	.13	.11	.25
mean[c]	9.57	9.23	9.20	9.33	9.62	9.11	9.03	9.25

[a] GSA biscuit cases (p.5) averaged 7.92%, case difference 0.10, rep deviation 0.02.
[b] Significant differences were 0.23 for item means, 0.15 for items in rooms.
[c] Significant differences were 0.17 and 0.18 for item means, 0.16 and 0.10 for items in rooms, at 18 and 24 months.

TABLE 3

CORROSION OF BAKERY ITEM CANS
(0-9 scale, 0 = none)

Condition °F/% r.h.	2½-gallon cans CD1	CD3	CD4	mean	Std.dif. cans	5-gallon cans CD2	CD5	CD6	CD7	CD8	CD9	CD10	Mean	Std.dif. cans
External, pitted: also surface (S) where indicated:														
100/80	1.2	1.1	1.3	1.20	.29	2.1	2.5	2.3	1.8	1.7	1.9S	2.1	2.06	.54
100/57	.4	.4	.8	.53	.17	1.3	.9	.9	1.0	.6	1.3S	1.1	1.01	.61
70/80	1.5	1.4	1.4	1.43	.12	2.0	1.0	.9	1.1	.9	1.3S	1.1	1.19	.53
70/57[a]	.3	.9	.7	.63	.20	.7	.6	.5S	.7	.3	.6	.7	.59	.23
40/57	.5	.1	.5	.37	.37	.5	.7	.6	.3	.4	.5	.4	.49	.37
0/amb	.3	.4	.2	.30	.20	.7	.5	.6	.3	.2	.3	.6	.46	.30
std.dif.,cans	.34	.15	.19	.24	–	.31	.51	.61	.40	.34	.44	.19	.45	–
sign.dif., 5%	.59	.25	.32	.21	.36[b]	.53	.88	1.05	.71	.61	.76	.32	.25	.71[b]
mean, 36 mo.	.70	.72	.82	.74	NS[c]	1.22	1.03	.97	.87	.68	.98	1.00	.96	.26[c]
Internal, surface: also pitted (P) where indicated:														
100/80	1.1	.6	.9P	.87	.20	.8	.6	.5	.7	.7	1.5P	.7	.79	.24
100/57	.8P	.3	.7P	.60	.35	.7P	.8P	.6P	.8	.9P	1.6P	.6	.86	.41
70/80	.8	1.1P	.9P	.93	.17	.6	.8P	.8P	.6	.9P	.9P	.6	.74	.27
70/57[a]	.7P	.7P	.7P	.70	.39	.5	.7P	.8P	.6	.8P	.6	.7	.68	.26
40/57	.7P	.4	.9P	.67	.29	.5	1.3P	.9P	.9P	1.3P	.6	.5	.86	.48
0/amb	.5	.5	.9P	.63	.29	.8P	1.2P	.5P	.5	.7	.6	.4	.67	.38
std.dif.,cans	.40	.19	.24	.29	–	.25	.40	.58	.28	.25	.36	.17	.35	–
sign.dif., 5%	NS	.32	NS	.26	.46[b]	NS	.68	NS	NS	.43	.62	.29	.16	.55[b]
mean, 36 mo.	.77	.60	.83	.73	.23[c]	.66	.90	.68	.68	.88	.98	.58	.77	.25[c]

[a]GSA biscuit cans (p.5) averaged 0.32 and 0.57, case differences 0.03 and 0.13, can differences 0.29 and 0.55, for external and internal corrosion.
[b]Significant difference for items in rooms.
[c]Significant difference for item means.

TABLE 4

CORROSION OF CARBOHYDRATE SUPPLEMENT CANS
(0-9 scale, 0 = none)

Condition °F/% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
External. pitted: also surface (S) where indicated:										
100/80	1.6S	.5	1.3S	1.13	.49	1.3S	.9	1.7S	1.30	.20
100/57	.7	.3	.9	.65	.13	.9	.8	1.1	.93	.44
70/80	.9	.4	1.3S	.85	.32	1.0	.6	1.1	.90	.49
70/57	.5	.4	.8	.58	.34	1.0	.7	.7	.80	.17
40/57	.4	1.0	.3	.73	.71	.9	.5	.4	.60	.39
0/amb	.3	.3	1.4	.67	.49	.7	.3	.7	.57	.20
std.dif.,cans	.46	.56	.47	.50	–	.49	.25	.20	.34	–
sign.dif., 5%	.78	NS	.60	.33	.78[a]	NS	.42	.35	.29	.55[a]
mean	.73	.49	1.08	.77	.35[b]	.97	.63	.95	.85	.22[b]
Internal. surface: also pitted (P) where indicated:										
100/80	.8P	1.0P	.7	.83	.35	.7	.6	1.1	.80	.20
100/57	.6	.8P	.6	.68	.32	.8	.9	.8	.83	.26
70/80	1.0P	.4P	.7	.70	.17	.8	.6	.6	.67	.17
70/57	.8P	.6P	.5	.63	.35	.9	.9	.7	.83	.20
40/57	.8P	.7P	.7P	.72	.56	.9	.6	.8	.77	.26
0/amb	.4	.3	.6	.43	.20	.6	.8	.8	.73	.24
std.dif.,cans	.35	.45	.20	.35	–	.17	.17	.31	.23	–
sign.dif., 5%	NS	NS	NS	.23	.54[a]	.29	.29	NS	NS	.36[a]
mean	.75	.63	.63	.67	NS[b]	.78	.73	.80	.77	NS[b]

[a] Significant difference for items in rooms.
[b] Significant difference for item means.

TABLE 5

DEFECTS IN CAN COATINGS
(0-9 scale, 0 = none)

Condition °F/% r.h.	2½-gallon cans CD1	CD3	CD4	mean	Std.dif. cans	5-gallon cans, bakery items CD2	CD5	CD6	CD7	CD8	CD9	CD10	mean	Std.dif. cans
100/80	.5	.8	1.5	.90	.17	1.6	1.5	1.0	1.4	1.5	1.5	1.1	1.37	.30
100/57	.4	.3	1.1	.60	.18	.9	1.0	.9	.9	.7	1.3	1.3	1.00	.44
70/80	.6	1.1	.9	.88	.18	1.3	.7	.6	.8	1.0	.9	.9	.89	.32
70/57[a]	.5	.9	.7	.70	.29	.7	.7	.4	.9	.6	.5	.7	.65	.33
40/57	.4	.2	.9	.50	.29	.7	.9	.5	.3	1.1	.5	.9	.70	.27
0/amb	.3	.6	.8	.57	.17	.9	.9	.8	.7	.8	.5	.6	.74	.44
std.dif.,cans	.28	.17	.19	.22	-	.29	.37	.33	.42	.40	.32	.34	.35	-
sign.dif., 5%	NS	.29	.32	.19	.36[b]	.50	.64	.57	.72	.69	.55	.59	.19	.57[b]
Mean, 36 mo.	.46	.65	.98	.70	.24[c]	1.02	.95	.70	.83	.95	.87	.92	.89	.21[c]

5-gallon cans, carbohydrate supplements

	18 months: CD11	CD12	CD13	Mean	Std.dif. cans	24 months: CD11	CD12	CD13	Mean	Std.dif. cans
100/80	1.15	.5	.9	.85	.47	.85	.75	1.0	.87	.22
100/57	1.1	.5	.85	.82	.29	.65	.95	.75	.79	.20
70/80	.65	.45	1.0	.70	.24	.8	.55	.9	.75	.24
70/57	.55	.45	1.4	.80	.30	1.05	.6	.75	.80	.15
40/57	.87	.87	.9	.88	.55	.95	.55	.55	.69	.10
0/amb	.5	.5	1.85	.95	.47	.6	.35	1.05	.67	.19
std.dif.,cans	.42	.43	.36	.40	-	.25	.13	.17	.19	-
sign.dif., 5%	.60	NS	.62	NS	.48[b]	.42	.22	.29	.16	.30[b]
mean	.80	.55	1.15	.83	.23[c]	.82	.63	.83	.76	.15[c]

[a] GSA biscuit cans (µ.5) averaged 0.67, case difference 0.13, can difference 0.55.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.

TABLE 6

LEAKING CANS
(as percentages of cans examined)

Products CD	Definite Leakers 0-18 mo.	24 mo.	36 mo.	total	Questionable Leakers 0-18 mo.	24 mo.	36 mo.	total
($2\frac{1}{2}$-gal.)[a]								
1	4.9	25.0	8.3	9.23	2.4	16.7	8.3	6.15
3	7.3	33.3	.0	10.77	4.9	.0	8.3	4.62
4	39.0	83.3	83.3	55.38	34.1	.0	.0	21.54
(5-gal.)								
2	.0	.0	.0	.00	2.4	.0	8.3	3.08
5	12.2	8.3	.0	9.23	2.4	8.3	16.7	6.15
6	17.9	41.7	41.7	26.98	2.6	.0	8.3	3.17
7	.0	8.3	.0	1.54	4.9	.0	.0	3.08
8	.0	.0	.0	.00	.0	8.3	.0	1.56
9	.0	.0	8.3	1.54	.0	.0	8.3	1.54
10	.0	.0	.0	.00	.0	.0	.0	.00
(5-gal.)	0-12 mo.	18 mo.	24 mo.	total	0-12 mo.	18 mo.	24 mo.	total
11	17.2	.0	8.3	11.32	17.2	.0	.0	9.43
12	3.4	.0	.0	1.89	3.4	.0	.0	1.89
13	10.3	16.7	.0	9.43	6.9	.0	.0	3.77
Condition °F/% r.h.	6-18 mo.	24 mo.	36 mo.[b]	total	6-18 mo.	24 mo.	36 mo.[b]	total
100/80	3.8	11.5	15.0	7.26	10.3	3.85	5.0	8.06
100/57	7.7	11.5	10.0	8.87	3.8	3.85	5.0	4.03
70/80	10.3	23.1	20.0	14.52	3.8	.00	.0	2.42
70/57	7.7	19.2	10.0	10.48	5.1	3.85	10.0	5.65
40/57	11.5	7.7	15.0	11.29	5.1	3.85	5.0	4.84
0/amb	9.0	23.1	15.0	12.90	6.4	.00	10.0	5.65
Total	8.33	16.03	14.17	10.67[c]	5.77	2.56	5.83	5.09[c]

[a]There were no leakers in 12 cans of GSA biscuits (p.5).
[b]Bakery items only (CD1-CD10); other columns include all items (CD1-CD13).
[c]Includes initial leakers.

TABLE 7

DEFECTS OF PACKAGES
(as percent of packages)

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Seals Broken:												
100/80	10.0	20.0	.0	2.1	.0	16.7	.0	2.1	.8	2.8	5.44	9.14
100/57	16.7	.0	2.1	43.8	.0	36.7	.0	.0	.4	.4	10.00	12.99
70/80	.0	10.0	4.2	54.2	.0	13.3	.0	.0	.0	.4	8.21	18.05
70/57	3.3	26.7	.0	8.3	.0	13.3	.0	.0	.8	2.0	5.45	10.19
40/57	3.3	10.0	.0	8.3	.0	20.0	.0	2.1	1.6	2.0	4.73	14.09
0/amb	3.3	23.3	2.1	10.4	.0	33.3	.0	2.1	.0	.4	7.5	21.14
std.dif.,cans	9.82	17.85	2.41	24.71	-	10.82	-	2.95	.73	.79	14.88	-
sign.dif., 5%	10.41	NS	2.56	42.01	-	11.47	-	NS	1.24	1.37	NS	21.04[b]
mean, 36 mo.	6.11	15.00	1.39	21.18	.00	22.22	.00	1.04	.60	1.32	6.89	9.21[c]
Packages Torn:												
100/80	10.0	3.3	.0	.0	.0	20.0	7.1	.0	1.2	.0	4.17	5.69
100/57	6.7	.0	.0	.0	.0	10.0	3.6	4.2	.0	.0	2.44	7.93
70/80	6.7	3.3	.0	35.4	.0	6.7	26.8	2.1	.4	.0	8.13	16.23
70/57	20.0	10.0	.0	.0	.0	.0	26.8	10.4	.0	.0	6.72	11.32
40/57	.0	.0	2.1	.0	.0	.0	8.9	6.3	1.6	1.2	2.00	5.98
0/amb	.0	6.7	2.1	.0	.0	10.0	21.4	6.3	.0	.4	4.68	14.48
std.dif.,cans	9.82	7.20	2.41	18.72	-	11.55	22.17	9.00	1.22	.46	11.01	-
sign.dif., 5%	10.41	NS	NS	31.82	-	NS	NS	NS	NS	.78	4.35	15.57[b]
mean, 36 mo.	7.22	3.89	.70	5.90	.00	7.78	15.77	4.86	.53	.26	4.69	7.79[c]

(cont'd)

Table 7 (cont'd)

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Total Packages Unsealed:												
100/80	13.3	20.0	.0	2.1	.0	30.0	7.1	2.1	1.6	2.8	7.90	8.91
100/57	20.0	.0	2.1	43.8	.0	40.0	3.6	4.2	.4	.4	11.44	12.84
70/80	6.7	10.0	4.2	64.6	.0	16.7	26.8	2.1	.4	.4	13.17	18.89
70/57	20.0	36.7	.0	8.3	.0	13.3	26.8	10.4	.8	2.0	11.83	15.08
40/57	3.3	10.0	2.1	8.3	.0	20.0	8.9	8.3	3.2	3.2	6.74	15.42
0/amb	3.3	23.3	4.2	10.4	.0	40.0	21.4	8.3	.0	.8	11.18	22.43
std.dif.,cans	13.88	18.06	2.41	23.33	-	31.04	22.17	9.47	1.22	1.13	16.17	-
sign.dif., 5%	NS	19.14	2.56	41.68	-	NS	NS	NS	2.07	2.00	6.39	25.86[b]
Mean, 36 mo.	11.11	16.67	2.09	22.92	.00	26.67	15.77	5.90	1.06	1.59	10.38	11.12[c]

[a]GSA biscuit packages (p.5) averaged 3.33% seals broken, 47.78% packages torn open, for a total of 48.89% unsealed packages; case differences were 2.22, 35.56 and 37.78; can differences were 8.78, 43.04 and 41.78, respectively.

[b]Significant difference for items in rooms.

[c]Significant difference for item means.

TABLE 8

BREAKAGE OF PRODUCTS
(as percent of total units)

Condition	Crackers				Biscuits[a]				Wafers		Mean	Std.dif.
°F/% r.h.	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10		cans
Score Lines Broken in Layers:												
100/80	25.7	17.2	6.8	5.2	6.6	9.2	1.5	11.4	(separate		10.46	6.25
100/57	31.6	17.4	21.5	8.1	5.1	5.4	1.1	6.5	units;		12.09	9.10
70/80	23.5	14.3	23.7	11.7	3.3	3.6	2.7	10.3	crumbled		11.65	4.19
70/57	25.4	18.4	10.2	9.0	4.8	2.7	3.4	11.0	edges		10.63	3.30
40/57	20.6	16.6	16.0	3.6	9.4	2.5	2.7	7.2	are		9.81	6.13
0/amb	33.6	22.6	10.5	7.1	2.6	4.7	1.8	11.0	omitted)		11.75	14.18
std.dif.,cans	17.37	5.08	9.52	3.55	6.48	3.79	2.05	5.24	–	–	8.05	–
sign.dif., 5%	NS	NS	12.85	6.04	NS	5.12	NS	NS	–	–	NS	11.46[b]
Mean, 36 mo.	26.73	17.76	14.80	7.46	5.31	4.67	2.20	9.57	–	–	11.06	4.30[c]
Moderate Unit Breakage:												
100/80	17.4	13.1	11.9	9.4	4.3	20.5	2.6	5.7	.3	.5	8.56	3.05
100/57	20.3	7.9	13.2	11.4	.9	18.5	1.2	3.6	.3	.3	7.75	4.16
70/80	9.5	17.8	18.1	20.1	1.0	13.9	2.8	5.0	.1	.3	8.86	2.73
70/57	17.1	18.7	10.7	12.7	1.0	10.3	3.6	6.0	.3	.3	8.08	2.56
40/57	14.5	11.6	23.4	15.3	3.1	14.2	3.2	4.4	.4	.4	9.04	2.22
C/amb	18.5	9.2	22.9	14.8	1.3	13.0	2.9	4.3	.1	.4	8.75	5.16
std.dif.,cans	3.57	4.82	5.39	3.41	1.74	5.76	2.10	1.63	.35	.39	3.47	–
sign.dif., 5%	4.82	6.51	7.27	5.90	2.35	7.77	NS	NS	NS	NS	NS	5.54[b]
Mean, 36 mo.	16.23	13.05	16.70	13.94	1.93	15.07	2.72	4.82	.24	.36	8.51	2.90[c]

(cont'd)

Table 8 (cont'd)

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CL8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Units Severely Crushed:												
100/80	1.3	.0	1.0	.0	.2	.7	.0	.0	.0	.0	.31	1.00
100/57	.2	.0	.7	.0	.0	1.6	.0	.0	.0	.0	.25	1.01
70/80	.0	.7	.9	3.5	.0	.0	.0	.0	.0	.0	.52	.59
70/57	.5	.9	.3	.3	.0	.0	.0	.5	.0	.0	.25	.71
40/57	.0	.0	1.7	.6	.1	.3	.0	.0	.0	.0	.27	.50
0/amb	.0	.1	.6	.4	.0	.0	.0	.0	.0	.0	.10	.28
std.dif.,cans	1.19	.88	.63	.82	.16	1.43	-	.07	-	-	.73	-
sign.dif., 5%	NS	NS	.85	1.41	NS	NS	-	.11	-	-	.29	1.08[b]
Mean, 36 mo.	.35	.28	.87	.79	.04	.43	.00	.09	.00	.00	.28	.53[c]
Total Product Breakage:												
100/80	31.6	30.3	19.6	12.0	11.1	25.7	4.1	17.1	.3	.5	18.93	3.43
100/57	36.3	25.3	39.4	15.4	6.0	22.8	2.3	10.1	.3	.3	19.71	8.54
70/80	21.2	32.8	42.7	29.5	4.3	15.7	5.5	15.3	.1	.3	20.89	3.44
70/57	30.4	38.0	21.2	17.5	5.8	11.7	7.0	17.5	.3	.3	18.63	3.23
40/57	24.7	28.7	41.1	17.6	12.5	15.7	5.9	11.5	.4	.4	19.67	6.92
0/amb	35.3	31.8	34.0	18.8	3.9	15.4	4.7	15.3	.1	.4	19.90	9.80
std.dif.,cans	9.44	5.57	10.59	4.34	8.14	7.14	3.79	5.94	.35	.39	6.47	-
sign.dif., 5%	12.74	7.52	14.29	7.51	NS	9.63	NS	NS	NS	NS	NS	9.15[b]
Mean, 36 mo.	29.91	31.09	33.00	18.46	7.28	17.85	4.92	14.47	.24	.36	19.62	4.68[c]

[a]GSA Biscuits (p.5) averaged 23.69% breakage at score lines, 12.46% moderate unit breakage, 7.56% crushed units, 31.87% total product breakage; case differences were 26.80, 12.61, 14.37 and 40.39; can differences were 23.80, 5.24, 13.42 and 23.49, respectively.
[b]Significant difference for items in rooms.
[c]Significant difference for item means.

TABLE 9

SENSORY SCORES FOR APPEARANCE-COLOR AND TEXTURE
(scale from 10 = excellent to 1 = poor)

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Appearance-Color:												
100/80	7.55	7.4	6.85	6.9	7.5	7.5	7.8	7.0	7.15	6.35	7.20	.34
100/57	7.25	7.25	6.95	7.0	7.55	7.35	7.7	7.0	7.35	6.3	7.17	.48
70/80	7.65	7.55	7.15	7.0	7.65	7.4	7.65	7.4	7.35	6.7	7.35	.43
70/57	7.8	7.65	7.3	7.05	7.9	7.4	7.6	7.4	7.45	6.7	7.43	.42
40/57	7.4	7.45	7.15	7.25	7.7	7.25	7.6	7.45	7.55	6.55	7.34	.50
0/amb	7.25	7.65	7.4	7.2	7.8	7.25	7.55	7.4	7.6	7.05	7.42	.41
std.dif.,cans	.30	.55	.58	.33	.40	.37	.21	.59	.31	.56	.43	–
sign.dif., 5%	.52	NS	NS	.35	NS	NS	NS	NS	.40	NS	.20	.84[b]
Mean, 36 mo.	7.48	7.49	7.13	7.07	7.68	7.36	7.65	7.28	7.41	6.61	7.32	.38[c]
Texture:												
100/80	6.5	6.5	6.3	6.6	7.0	6.8	6.6	6.9	6.6	6.2	6.60	.44
100/57	6.3	6.6	6.3	6.4	7.0	6.5	6.6	7.0	6.7	6.2	6.56	.53
70/80	7.1	7.3	6.8	6.9	7.4	7.4	7.0	7.1	6.4	6.3	6.97	.45
70/57	6.9	7.5	7.4	6.7	7.5	7.2	7.2	7.1	6.5	6.4	7.04	.37
40/57	7.0	7.6	7.2	7.1	7.5	7.0	7.3	7.2	6.7	6.6	7.12	.42
0/amb	7.1	7.2	7.1	6.8	7.7	7.1	7.2	7.7	6.6	6.7	7.12	.41
std.dif.,cans	.25	.56	.40	.28	.49	.45	.25	.68	.51	.31	.44	–
sign.dif., 5%	.43	.95	.68	.48	.70	.77	.43	NS	NS	.40	.20	.83[b]
Mean, 36 mo.	6.82	7.12	6.85	6.75	7.35	7.00	6.98	7.17	6.58	6.40	6.90	.38[c]

[a] GSA biscuits (p.5) averaged 7.36 for appearance-color and 7.28 for texture; case differences were 0.08 and 0.17, can differences 0.70 and 0.55, respectively.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.

TABLE 10

HUNTER COLOR VALUES

Condition °F/% r.h.	Crackers CD1	Crackers CD3	Crackers CD5	Crackers CD8	Biscuits[a] CD2	Biscuits[a] CD4	Biscuits[a] CD6	Biscuits[a] CD7	Wafers CD9	Wafers CD10	Mean	Std.dif. cans
L values:												
100/80	66.6	74.3	62.2	74.8	73.9	78.1	65.6	74.8	63.4	60.6	69.42	1.19
100/57	67.6	73.8	62.6	74.5	74.7	77.6	65.3	74.7	62.8	57.9	69.13	.81
70/80	66.6	73.2	62.0	71.9	72.3	76.3	65.2	73.9	64.2	60.3	68.58	.78
70/57	65.5	72.6	61.7	70.8	73.1	78.4	64.9	72.4	64.0	60.3	68.37	1.01
40/57	61.1	71.4	61.7	71.0	71.1	75.2	62.7	72.4	62.8	58.2	66.77	.73
0/amb	63.8	70.8	60.0	71.1	70.9	75.6	63.2	70.9	62.6	57.5	66.64	1.32
std.dif.,cans	1.11	.80	.88	1.03	1.31	.91	.75	1.28	.38	1.15	1.00	–
sign.dif., 5%	1.91	1.39	1.52	1.78	2.38	1.58	1.29	2.33	.66	1.99	.45	1.59[b]
Mean, 36 mo.	65.20	72.68	61.70	72.34	72.66	76.87	64.48	73.19	63.27	59.12	68.15	.61[c]
"a" values:												
100/80	4.0	.1	6.7	1.1	.7	.4	4.3	1.3	3.9	3.9	2.62	.56
100/57	3.9	.2	6.8	1.6	.6	.4	4.7	1.6	4.2	4.9	2.89	.57
70/80	4.1	.3	6.6	2.3	1.5	.9	4.5	1.9	3.3	4.4	2.98	.54
70/57	4.7	.6	6.8	2.6	1.3	-.4	4.2	2.8	3.4	4.4	3.03	.49
40/57	6.0	1.3	7.2	2.2	1.8	1.2	4.8	2.1	3.9	4.9	3.54	.35
0/amb	5.2	1.7	7.8	2.2	2.0	.9	5.2	2.9	3.8	4.8	3.65	.69
std.dif.,cans	.28	.32	.46	.78	.56	.84	.54	.60	.40	.39	.54	–
sign.dif., 5%	.49	.56	.78	1.33	.97	1.43	.92	1.04	.68	.67	.25	.87[b]
Mean, 36 mo.	4.65	.70	6.98	1.99	1.32	.56	4.60	2.09	3.75	4.54	3.12	.28[c]

(cont'd)

Table 10 (cont'd)

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
"b" values:												
100/80	24.9	22.5	24.1	22.2	21.2	22.1	24.6	21.1	21.5	19.7	22.37	.40
100/57	25.1	22.8	24.7	22.5	21.0	22.3	25.1	21.6	21.9	19.2	22.61	.42
70/80	24.9	22.3	23.8	22.0	20.9	21.5	24.4	21.7	21.3	19.8	22.25	.54
70/57	25.0	22.4	24.0	21.4	20.9	21.7	24.0	22.1	21.1	19.5	22.20	.28
40/57	23.6	22.4	24.6	21.7	20.8	21.6	23.8	21.5	21.2	19.8	22.09	.34
0/amb	24.7	22.5	23.9	22.0	20.4	21.6	24.4	21.6	21.3	19.1	22.15	.34
std.dif.,cans	.30	.16	.29	.37	.37	.52	.57	.50	.28	.36	.39	–
sign.dif., 5%	.51	.27	.51	.63	.63	.80	.97	.85	.43	.61	.18	.62[b]
Mean, 36 mo.	24.70	22.48	24.18	21.95	20.87	21.79	24.38	21.57	21.35	19.50	22.28	.23[c]
a/b ratios:												
100/80	.159	.006	.277	.047	.031	.017	.174	.062	.180	.199	.117	.026
100/57	.155	.011	.275	.070	.029	.019	.185	.074	.193	.254	.128	.025
70/80	.165	.012	.277	.106	.074	.040	.184	.088	.155	.220	.134	.023
70/57	.190	.028	.284	.120	.063	-.018	.173	.126	.159	.224	.137	.023
40/57	.254	.056	.293	.096	.088	.056	.203	.099	.184	.248	.160	.015
0/amb	.240	.075	.327	.100	.098	.043	.214	.132	.180	.251	.165	.032
std.dif.,cans	.013	.015	.021	.034	.027	.039	.018	.028	.015	.017	.024	–
sign.dif., 5%	.023	.025	.036	.058	.049	NS	.031	.048	.026	.031	.010	.034[b]
Mean, 36 mo.	.188	.031	.289	.090	.063	.026	.189	.097	.175	.233	.140	.013[c]

[a] GSA biscuits (p.5) averaged 68.26 for L, 4.34 for "a", 21.23 for "b", 0.204 for a/b; case differences were 1.72, 0.27, 0.05 and 0.013; can differences were 1.34, 0.64, 0.50 and 0.030, respectively.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.

TABLE 11

FRACTURE STRENGTH OF RATION UNITS
(grams)

Condition	Crackers				Biscuits[a]				Wafers		Mean	Std.dif.
°F/% r.h.	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10		cans
100/80	1276	1060	1432	1152	1634	961	2018	1165	2600	1599	1490	106
100/57	1332	1050	1496	1136	1617	1086	1903	1163	2442	1683	1489	70
70/80	1384	1086	1545	1131	1714	1115	2068	1177	2412	1544	1517	83
70/57	1400	1130	1442	1190	1707	1139	2033	1178	2549	1692	1546	114
40/57	1433	1172	1542	1177	1655	1117	2120	1187	2306	1623	1533	151
0/amb	1300	1177	1520	1101	1737	1125	2019	1108	1929	1590	1461	93
std.dif.,cans	61	112	132	93	77	87	77	36	196	103	106	–
sign.dif., 5%	103	NS	NS	NS	110	128	130	60	339	NS	48	169[b]
Mean, 36 mo.	1354	1109	1496	1148	1677	1090	2027	1163	2373	1622	1506	31[c]

[a]GSA biscuits (p.5) averaged 1402, case difference 44, can difference 87.
[b]Significant difference for items in rooms.
[c]Significant difference for item means.

TABLE 12

RESIDUAL OXYGEN IN CANS AND MOISTURE CONTENT OF RATION UNITS

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Residual Oxygen, percent by volume:												
100/80	15.4	10.0	4.1	10.1	11.2	20.4[b]	5.6	8.8	6.6	7.1	9.94	1.81
100/57	13.5	13.9	9.6	10.1	8.4	20.2[b]	8.5	12.6	3.9	7.2	10.80	2.18
70/80	17.0	15.7	12.2	15.0	17.1	20.2[b]	15.5	18.0	4.2	6.3	14.12	1.78
70/57	16.5	16.5	13.3	15.7	17.1	18.8	15.5	18.4	6.9	8.3	14.50	2.26
40/57	18.4	19.1	16.2	18.4	18.3	20.9[b]	15.4	19.7	8.5	9.0	16.38	1.48
0/amb	19.1	20.0	18.6	20.0	19.7	20.5	17.0	20.4	15.9	15.3	18.65	.17
std.dif.,cans	1.68	.71	.84	1.90	3.20	.63	2.20	.94	2.55	2.76	1.96	-
sign.dif., 5%	2.86	1.21	1.43	3.23	5.44	1.08	3.74	1.60	4.34	4.69	.88	2.80[c]
Mean, 36 mo.	16.66	15.37	12.33	14.88	15.31	20.17	12.58	16.22	7.67	8.87	14.07	1.84[d]
Moisture Content, percent:												
100/80	3.34	2.60	1.62	3.26	2.24	2.39[b]	2.63	2.07	3.33	3.20	2.68	.29
100/57	3.06	2.69	1.74	3.37	2.52	2.32[b]	2.78	2.03	3.49	2.96	2.70	.24
70/80	3.27	2.55	1.89	3.12	2.57	2.06[b]	2.65	2.12	3.39	3.40	2.70	.23
70/57	3.03	2.57	1.78	3.09	2.74	2.79	2.74	2.03	3.50	3.51	2.78	.23
40/57	2.13	2.89	2.32	2.75	2.23	2.65[b]	2.69	2.17	3.41	3.59	2.68	.35
0/amb	3.24	2.63	2.04	2.90	2.54	2.27	2.64	1.95	3.35	3.43	2.70	.25
std.dif.,cans	.27	.26	.17	.62	.23	.16	.11	.22	.11	.06	.27	-
sign.dif., 5%	.46	NS	.30	NS	.39	.27	NS	NS	NS	.11	NS	.44[c]
Mean, 36 mo.	3.01	2.66	1.90	3.08	2.49	2.41	2.68	2.06	3.41	3.35	2.71	.15[d]

[a] CSM biscuits (p.5) averaged 17.80% oxygen and 1.12% moisture; case differences were 0.70 and 0.03, can differences were 1.13 and 0.29, respectively.

[b] Both cans leaked; single leakers, omitted here, averaged 4.1 ± 3.8 higher in oxygen and 0.04 ± 0.44 lower in moisture than duplicate non-leakers.

[c] Significant difference for items in rooms.

[d] Significant difference for item means.

TABLE 13

RANCIDITY VALUES OF FATS FROM SHELTER RATIONS

Condition °F/% r.h.	Crackers CD1	CD3	CD5	CD8	Biscuits[a] CD2	CD4	CD6	CD7	Wafers CD9	CD10	Mean	Std.dif. cans
Peroxide Values, milliequivalents per kilogram:												
100/80	1.0	2.4	1.9	1.6	2.1	1.3[b]	1.2	1.7	.2	.1	1.37	.36
100/57	4.0	1.0	1.9	2.6	3.2	1.4[b]	.2	1.5	.1	.1	1.59	.84
70/80	2.9	2.5	1.1	1.4	.4	.7[b]	.3	.8	.1	.1	1.02	.97
70/57	2.4	2.0	1.0	1.5	.3	.8	.4	.7	.1	.2	.95	.41
40/57	.4	1.1	.2	.1	.4	.3	.2	.3	.4	.2	.35	.19
0/amb	.2	.4	.2	.1	.2	.2	.3	.3	.4	.1	.24	.17
Std.dif.,cans	1.42	.98	.62	.58	.38	.41	.24	.45	.14	.17	.65	–
Sign.dif., 5%	2.42	1.67	1.06	1.01	.65	.71	.41	.77	.24	NS	.29	1.03[c]
Mean, 36 mo.	1.82	1.59	1.03	1.23	1.09	.77	.44	.89	.19	.13	.92	.39[d]
Free Fatty Acids, percent as oleic acid:												
100/80	.28	.96	.56	.53	.40	.88	.17	.44	.61	.50	.534	.199
100/57	.54	.63	.27	.55	.39	.82	.15	.43	.69	.48	.494	.168
70/80	.17	.29	.19	.31	.18	.59	.10	.32	.42	.35	.291	.028
70/57	.13	.27	.22	.29	.15	.66	.10	.30	.40	.37	.288	.036
40/57	.13	.25	.18	.31	.18	.61	.10	.29	.40	.38	.283	.026
0/amb	.13	.23	.14	.33	.16	.60	.09	.28	.38	.37	.270	.017
Std.dif.,cans	.217	.173	.182	.047	.022	.017	.018	.040	.034	.024	.108	–
Sign.dif., 5%	.369	.299	.310	.081	.039	.029	.031	.068	.059	.041	.049	.173[c]
Mean, 36 Mo.	.230	.440	.259	.386	.244	.694	.118	.342	.482	.409	.360	.055[d]

[a]GSA biscuits (p.5) averaged 0.25 peroxides and 0.261% free fatty acids; case differences were 0.06 and 0.001, can differences were 0.20 and 0.034, respectively.

[b]Both cans leaked; single leakers, omitted here, averaged .24 ± .68 higher in peroxides and -.005 ± .022 lower in free fatty acids than duplicate non-leakers.

[c]Significant difference for items in rooms.

[d]Significant difference for item means.

TABLE 14

SENSORY SCORES FOR AROMA AND FLAVOR

Condition °F/% r.h.	Crackers CL1	Crackers CD3	Crackers CD5	Crackers CL8	Biscuits[a] CL2	Biscuits[a] CD4	Biscuits[a] CL6	Biscuits[a] CL7	Wafers CD9	Wafers CD10	Mean	Std.dif. cans
Aroma:												
100/80	4.4	3.6	4.4	4.0	4.3	5.0	4.8	3.6	5.2	5.3	4.40	.45
100/57	3.8	4.0	4.3	4.5	4.3	4.9	5.0	3.7	5.4	4.7	4.37	.79
70/80	6.5	6.1	6.2	5.8	6.5	5.2	6.0	5.9	5.0	5.0	5.93	.39
70/57	7.1	6.[illegible]	6.5	6.3	6.6	6.3	6.4	5.8	5.3	5.5	6.22	.49
40/57	7.1	7.1	6.7	7.1	6.9	6.7	7.3	6.9	6.2	6.6	6.85	.31
0/amb	7.[illegible]	7.1	7.2	7.1	7.4	6.7	7.4	7.5	6.4	6.6	7.07	.64
std.dif., cans	.87	.57	.43	.37	.17	.60	.41	.40	.44	.73	.54	–
sig.dif., 5%	1.50	1.01	.74	.64	.29	1.04	.71	.70	.77	1.31	.24	.86[b]
mean, 36 mo.	6.03	5.70	5.88	5.80	6.00	5.73	6.15	5.57	5.58	5.62	5.81	.23[c]
Flavor:												
100/80	4.2	3.7	4.2	4.4	4.3	5.0	5.7	4.5	5.8	5.6	4.74	.72
100/57	5.4	5.9	4.1	4.6	4.2	4.9	5.0	4.4	5.9	5.6	4.60	.80
70/80	6.5	6.3	6.2	6.4	6.5	6.2	6.2	6.4	5.7	5.3	6.15	.51
70/57	6.6	6.6	6.6	6.5	6.5	6.3	7.0	6.2	5.7	5.7	6.37	.39
40/57	6.7	6.9	7.1	6.8	7.7	6.7	7.1	7.1	7.0	7.1	7.02	.53
0/amb	6.9	7.0	7.1	6.9	7.9	6.7	7.4	7.4	7.3	6.8	7.14	.43
std.dif., cans	.80	.44	.46	.45	.70	.52	.71	.12	.64	.65	.58	–
sig.dif., 5%	1.38	.76	.79	.78	1.21	.90	1.22	.21	1.10	1.15	.26	.93[b]
mean, 36 mo.	5.72	5.73	5.88	5.93	6.15	5.97	6.40	6.00	6.23	6.02	6.00	.21[c]

[a] GSA biscuits (p.5) averaged 6.58 aroma score and 6.80 flavor score; case differences were 0.17 and 0.07, can differences 0.86 and 0.80, respectively.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.

TABLE 15

HEDONIC RATINGS FOR AROMA, FLAVOR AND PALATABILITY

Condition °F/% r.h.	Crackers CD1	Crackers CD3	Crackers CD5	Crackers CD8	Biscuits[a] CD2	Biscuits[a] CD4	Biscuits[a] CD6	Biscuits[a] CD7	Wafers CD9	Wafers CD10	Mean	Std.dif. cans
Aroma:												
100/80	4.66	3.96	3.94	4.44	4.94	4.66	4.50	4.90	5.34	5.44	4.68	.43
100/57	4.48	4.40	4.36	4.62	4.92	4.66	4.74	4.86	5.12	5.52	4.77	.41
70/80	6.02	5.92	5.78	5.62	6.32	5.90	5.78	5.94	4.72	5.14	5.71	.23
70/57	6.16	5.76	5.92	5.84	6.22	5.88	5.52	5.88	5.08	5.24	5.75	.34
40/57	6.10	6.24	5.76	5.96	6.42	6.10	5.60	5.88	5.48	5.96	5.95	.29
0/amb	6.00	6.06	5.78	5.90	6.46	6.10	5.90	6.34	5.64	5.82	6.00	.23
std.dif.,cans	.40	.48	.47	.43	.20	.37	.23	.14	.23	.30	.34	–
sign.dif., 5%	.69	.82	.80	.74	.34	.64	.39	.24	.41	.53	.16	.54[b]
mean, 36 mo.	5.57	5.39	5.26	5.40	5.88	5.55	5.34	5.63	5.23	5.52	5.48	.27[c]
Flavor:												
100/80	4.74	4.10	3.84	4.54	5.28	4.82	4.72	5.20	5.36	5.52	4.81	.50
100/57	4.34	4.32	4.22	4.74	4.94	4.80	4.58	5.14	5.22	5.66	4.80	.42
70/80	5.74	5.98	5.58	5.76	6.30	5.66	5.76	6.10	5.14	5.04	5.71	.27
70/57	6.04	5.68	5.76	5.90	6.48	5.78	5.76	6.22	5.14	5.14	5.79	.32
40/57	6.00	6.18	5.72	5.94	6.72	5.92	5.80	6.14	5.82	6.14	6.04	.30
0/amb	5.90	6.04	5.76	5.88	6.58	6.04	6.08	6.40	5.80	5.98	6.05	.20
std.dif.,cans	.34	.32	.56	.50	.23	.16	.30	.25	.35	.30	.35	–
sign.dif., 5%	.58	.56	.97	.86	.39	.28	.51	.43	.60	.53	.16	.56[b]
Mean, 36 mo.	5.46	5.38	5.15	5.46	6.05	5.50	5.45	5.87	5.41	5.58	5.53	.27[c]

(cont'd)

Table 15 (cont'd)

Condition	Crackers				Biscuits[a]				Wafers		Mean	Std.dif.
°F/% r.h.	CD1	CD3	CD5	CD8	CD2	CD4	CD6	CD7	CD9	CD10		cans
Palatability:												
100/80	5.44	5.02	4.88	4.82	6.04	5.32	4.98	5.38	5.54	5.56	5.30	.47
100/57	5.50	5.10	4.90	4.92	5.96	5.24	4.80	5.44	5.36	5.68	5.29	.34
70/80	6.12	6.28	5.74	5.70	6.58	5.90	5.38	6.06	5.24	5.44	5.84	.32
70/57	6.14	6.06	5.82	5.94	6.54	6.02	5.60	6.22	5.52	5.46	5.93	.32
40/57	6.06	6.30	5.82	5.86	6.74	6.04	5.76	6.12	5.90	5.96	6.06	.35
0/amb	5.98	6.12	5.74	5.92	6.68	6.16	5.82	6.34	5.86	5.88	6.05	.25
std.dif.,cans	.29	.21	.21	.73	.21	.27	.30	.43	.21	.13	.35	–
sign.dif., 5%	.52	.37	.36	1.04	.36	.46	.52	.73	.53	.23	.16	.56[b]
Mean, 36 mo.	5.87	5.81	5.48	5.53	6.42	5.78	5.39	5.93	5.57	5.65	5.75	.29[c]

[a] GSA biscuits (p.5) averaged 6.31 for aroma, 6.53 for flavor, 6.57 for palatability; case differences were 0.12, 0.02, 0.06; can differences 0.49, 0.57 and 0.45; respectively.
[b] Significant difference for items in rooms.
[c] Significant difference for item means.

TABLE 16

CORRELATIONS OF PALATABILITY RATINGS WITH OTHER MEASUREMENTS
(r, simple correlation coefficients)

Palatability with:

Products items	Hunter Color Values L	Hunter Color Values "a"	Hunter Color Values "b"	Hunter Color Values a/b	Fracture Strength	Moisture Content	Residual Oxygen	Rancidity Values P.V.	Rancidity Values F.F.A.	Total Quality score
Crackers:										
CD1	-.450	+.167	-.347	+.504	+.699[a]	+.012	+.737[b]	-.458	-.743[b]	+.921[b]
3	-.046	+.608[a]	-.576[a]	+.610[a]	+.626[a]	-.050	+.813[b]	-.136	-.873[b]	+.935[b]
5	-.377	+.250	-.360	+.309	+.326	+.625[a]	+.809[b]	-.746[b]	-.685[a]	+.921[b]
8	-.315	+.612[a]	-.494	+.199	+.065	-.330	+.624[a]	-.420	-.705[a]	+.725[b]
All	-.054	+.003	-.036	+.009	+.734[b]	+.100	+.736[b]	-.310[a]	-.618[b]	+.825[b]
Biscuits:										
CD2	-.767[b]	+.719[b]	-.509	+.717[b]	+.514	+.157	+.996[b]	-.910[b]	-.889[b]	+.948[b]
4	-.493	+.174	-.803[b]	+.207	+.470	+.199	-.054	-.830[b]	-.892[b]	+.886[b]
6	-.691[a]	+.279	-.712[b]	+.046	+.627[a]	+.012	+.869[b]	-.463	-.282	+.796[b]
7	-.263	+.862[b]	+.431	+.273	+.065	-.262	+.852[b]	-.708[b]	-.761[b]	+.926[b]
All	+.148	-.289[a]	-.676[b]	-.228	-.111	-.178	+.556[b]	-.226	-.165	+.621[b]
Wafers:										
CD9	-.468	+.094	-.445	+.014	-.321	-.134	+.549	+.502	-.109	+.845[b]
10	-.659[a]	+.536	-.695[a]	+.557	+.155	+.249	+.641[a]	+.142	-.063	+.631[a]
Both	-.321	+.252	-.206	+.079	-.191	-.025	+.578[b]	+.325	-.140	+.576[b]

[a]Significant at the 5% level of probability.
[b]Significant at the 1% level of probability.

2210.3 #IV

TABLE 17

RESULTS OF SEAM TESTS ON CANDY BAGS

Condition °F/% r.h.	18 months CD11	18 months CD12	18 months CD13	18 months Mean	18 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Partial or total separation; percentage of seams:[a]										
100/80	3.9	.0	38.8[b]	14.29	4.78	1.3	.0	.0	0.42	1.45
100/57	1.3	3.8	1.3	2.08	4.79	43.8	.0	.0	14.58	4.34
70/80	7.5	.0	31.3[b]	13.86	4.57	8.3	7.5	13.4[b]	9.38	14.33
70/57	1.3	1.3	9.8[b]	4.17	3.26	.0	.0	3.8[b]	1.25	1.45
40/57	.0	.0	5.0	1.67	2.61	.0	.0	35.0[b]	11.67	2.89
0/amb	3.8	3.7	15.4[b]	7.50	8.68	.0	2.9	18.8[b]	7.39	21.92
std.dif.,cans	4.79	3.39	6.74	5.16	-	3.32	4.74	18.03	10.93	-
sign.dif., 5%	NS	NS	11.65	4.43	6.28[c]	5.75	7.50	30.65	9.42	17.55[c]
Mean	2.51	1.45	16.88	7.07	6.61[d]	8.90	1.70	11.83	7.51	NS[d]
Mean separation, defective seams; inches:[a]										
100/80	.063	-	.212	.199	.041	.063	-	-	.063	.037
100/57	.063	.063	.063	.063	.063	.193	-	-	.193	.073
70/80	.063	-	.225	.208	.037	.125	.073	.120	.109	.037
70/57	.063	.063	.156	.138	.059	-	-	.125	.125	.108
40/57	-	-	.109	.109	.036	-	-	.223	.223	.034
0/amb	.063	.063	.188	.146	.096	-	.625[e]	.250	.294	.389
std.dif.,cans	.052	.037	.081	.060	-	.058	.256	.133	.170	-
sign.dif., 5%	NS	.063	.138	.054	.095[c]	.098	.435	.226	.114	.272[c]
Mean (weighted)	.063	.063	.200	.175	.043[d]	.180	.211	.205	.196	NS[d]

[a] Mean values for 0-12 months were 2.84, 2.37, 13.79, av. 6.41% of seams; mean separation of these seams was .083, .063, .188, av. 158 inch, respectively.

[b] Includes seams which separated completely on seam test; for CD13 bags, these averaged 7.50% of all seams examined at 0-12 months, 9.46% at 18-24 months.

[c] Significant difference for items in rooms.

[d] Significant difference for item means.

[e] From a packet of bags with a 5/8-inch seam on one side; two of these separated completely on test.

TABLE 18

PHYSICAL CONDITION OF CANDY

Condition °F./% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Pieces Stuck Together, percent by count:										
100/80	6.3	.0	.3	2.20	1.85	2.4	.1	.2	.90	.39
100/57	1.0	.0	.6	.54	.76	1.4	.1	.7	.70	.35
70/30	1.5	.1	.5	.67	.91	1.1	.2	.1	.44	1.01
70/57	2.9	.1	.1	1.03	.92	.1	.0	.3	.15	.19
40/57	1.5	.0	.5	.68	.32	.3	.1	.2	.21	.23
0/amb	.9	.2	.4	.52	.52	1.7	.0	.8	.83	.39
std.dif.,cans	1.67	.09	.43	1.00	–	.77	.12	.41	.51	–
sign.dif., 5%	2.04	.12	NS	.61	1.49[a]	.94	NS	.51	.31	.59[a]
Mean	2.36	.08	.38	.94	.65[b]	1.16	.08	.30	.54	.28[b]
Chipped Pieces, percent by count:[c]										
100/80	6.2	7.8	5.3	6.41	2.80	2.4	10.0	3.2	5.20	.95
100/57	2.6	6.0	6.7	5.12	.92	3.8	16.8	3.7	8.10	.97
70/30	3.5	5.1	6.7	5.09	1.61	4.1	20.2	5.8	10.03	3.10
70/57	4.7	8.8	10.0	7.61	4.48	2.7	10.4	4.0	5.68	.85
40/57	3.9	4.7	4.2	4.22	2.34	3.5	19.3	5.0	9.27	2.86
0/amb	2.6	6.1	9.0	5.89	.73	2.2	14.9	4.9	7.31	2.15
std.dif.,cans	3.40	1.99	1.78	2.50	–	2.29	2.28	1.46	2.04	–
sign.dif., 5%	NS	2.43	2.18	1.56	3.28[a]	NS	2.79	1.79	1.24	2.28[a]
Mean	3.89	6.39	6.98	5.75	1.28[b]	3.12	15.25	4.43	7.60	1.00[b]

(cont'd)

Table 18 (cont'd)

Condition °F/% r.h.	13 months CD11	13 months CD12	13 months CD13	13 months Mean	13 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Pieces Broken Up, percent by count:[d]										
100/80	-.1	-.3	2.3	.65	.99	.7	-.3	.4	.28	.44
100/57	.3	-.1	2.2	.30	.45	-.6	-.5	.0	-.36	.43
70/80	.0	-.2	.5	.12	.90	-.2	-.2	.1	-.10	.64
70/57	.8	-.1	2.2	1.01	.93	.5	-.4	.8	.29	.93
40/57	.8	.1	1.5	.79	.19	-.[illegible]	-1.2	.6	-.23	1.42
0/amb	.3	.1	2.4	.93	.75	1.2	-1.0	.2	.12	1.10
std.dif.,cans	.96	.19	.91	.77	-	.80	1.31	.34	.91	-
sign.dif., 5%	NS	.24	1.12	.51	.88[a]	.98	NS	.42	.56	1.01[a]
Mean	.35	-.07	1.86	.72	.32[b]	.24	-.60	.36	.00	.33[b]
Material Passing 3-mesh Sieve, percent by weight:[e]										
100/80	3.1	.5	1.5	1.68	.96	2.7	.7	.7	1.37	1.35
100/57	3.6	.6	.9	1.68	2.38	4.3	.8	1.0	2.00	3.20
70/80	2.0	.4	.9	1.11	.47	3.3	.5	.4	1.49	1.95
70/57	3.2	.2	.7	1.39	1.30	1.8	.5	.7	.98	.28
40/57	1.9	.6	1.2	1.21	.29	2.3	.5	.7	1.19	.13
0/amb	4.8	.[illegible]	.6	1.89	1.33	2.7	.5	1.2	1.47	.54
std.dif.,cans	2.27	.03	.14	1.[illegible]1	-	2.83	.09	.25	1.64	-
sign.dif., 5%	NS	.05	.25	NS	2.05[a]	NS	.16	.31	NS	2.90[a]
Mean	3.09	.43	.95	1.49	.78[b]	2.84	.57	.36	1.42	.85[b]

[a] Significant difference for items in rooms.
[b] Significant difference for item means.
[c] Pieces with less than 25% broken off; reductions from normal weight for the three items averaged 25.9, 2.6, and 11.1%.
[d] Estimated as count in excess of amounts of chips required to restore chipped pieces to normal weight; negative values indicate chips discarded from chipped pieces before packing in the cans.
[e] Most of this material was sanding sugar.

TABLE 19

SENSORY SCORES FOR APPEARANCE-COLOR AND TEXTURE OF CARBOHYDRATE SUPPLEMENTS
(scale from 10 = excellent to 1 = poor)

Condition °F/% r.h.	18 months CD11	18 months CD12	18 months CD13	18 months Mean	18 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Appearance-Color:										
100/80	6.2	7.35	7.45	7.00	.22	7.35	7.55	7.1	7.33	.40
100/57	6.0	7.3	7.3	6.87	.26	7.55	7.35	6.9	7.27	.28
70/80	7.25	7.7	8.0	7.65	.21	7.7	7.7	7.8	7.73	.29
70/57	7.5	7.55	8.3	7.78	.18	7.6	7.65	7.5	7.58	.13
40/57	7.6	8.0	8.2	7.93	.40	7.45	7.9	7.8	7.72	.29
0/amb	7.6	7.85	8.3	7.92	.51	8.15	8.0	8.45	8.20	.09
std.dif.,cans	.44	.26	.22	.32	–	.26	.20	.32	.27	–
sign.dif., 5%	.76	.45	.38	.28	.51[a]	.45	.35	.56	.24	.44[a]
Mean	7.03	7.63	7.93	7.53	.39[b]	7.63	7.69	7.59	7.64	NS[b]
Texture:										
100/80	7.2	7.7	7.9	7.60	.17	7.6	7.8	7.9	7.77	.35
100/57	6.6	7.7	7.9	7.40	.64	7.4	7.6	7.8	7.60	.24
70/80	7.7	7.8	7.8	7.77	.53	7.6	7.7	7.7	7.67	.29
70/57	7.7	7.7	7.5	7.63	.39	7.6	7.6	7.9	7.70	.35
40/57	7.7	7.5	7.2	7.47	.37	7.7	7.9	8.0	7.87	.17
0, amb	7.6	7.3	7.4	7.43	.26	7.4	8.0	8.2	7.87	.40
std.dif.,cans	.22	.64	.28	.42	–	.38	.31	.22	.31	–
sign.dif., 5%	.38	NS	.51	.36	.67[a]	NS	NS	.38	.26	.50[a]
Mean	7.42	7.62	7.62	7.55	NS[b]	7.55	7.77	7.92	7.74	.18[b]

[a]Significant difference for items in rooms.
[b]Significant difference for item means.

TABLE 20

HUNTER COLOR VALUES OF CARBOHYDRATE SUPPLEMENTS, LEMON TYPE

Condition T/% R.H.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Hunter L Value:										
100/80	65.5	68.1	72.[illegible]	68.28	2.45	65.9	68.0	72.1	68.67	2.07
100/57	70.2	67.7	72.1	69.[illegible]	.65	69.4	69.5	72.[illegible]	70.29	.98
70/80	69.8	68.2	71.0	69.64	.91	66.8	70.1	71.1	69.[illegible]	.52
70/57	70.2	66.4	70.2	68.93	.56	66.6	69.1	72.1	69.[illegible]	2.01
40/57	69.9	68.2	71.0	69.72	.67	65.0	67.5	72.[illegible]	68.30	2.70
0/amb	69.7	67.7	70.6	69.[illegible]	1.16	70.2	68.2	72.[illegible]	70.[illegible]	.86
std.dif.,cans	1.32	.91	1.45	1.25	-	2.68	.95	.[illegible]8	1.72	-
sign.dif., 5%	2.29	1.55	NS	1.10	2.00[a]	4.64	1.65	NS	1.48	2.75[a]
Mean	69.22	67.72	71.03	69.32	.7[illegible][b]	67.[illegible]5	68.83	72.[illegible]0	69.40	.90[b]
Hunter "a" Value:										
100/80	-1.[illegible]	1.1	-10.1	-3.41	.58	-2.6	2.1	-8.7	-[illegible].06	2.26
100/57	-4.1	1.5	-9.9	-4.17	.77	-1.8	2.0	-8.9	-2.90	4.22
70/80	-5.5	1.0	-10.1	-4.85	.74	.9	1.1	-8.5	-2.17	[illegible].89
70/57	-6.2	4.7	-9.1	-3.54	.76	-5.0	.8	-8.8	-4.[illegible]5	1.20
40/57	-6.9	0.9	-9.5	-5.19	1.05	-2.8	2.0	-9.8	-[illegible].55	2.[illegible]
0/amb	-4.[illegible]	4.5	-9.8	-3.2[illegible]	.98	-5.1	2.4	-10.1	-4.25	2.31
std.dif.,cans	1.10	.35	.55	.86	-	4.86	1.00	.71	2.89	-
sign.dif., 5%	1.89	1.47	NS	.78	1.38[a]	NS	1.60	1.23	NS	4.64[a]
mean	-4.73	2.28	-9.75	-4.07	.82[b]	-2.75	1.73	-9.11	-[illegible]	1.15[b]

(cont'd)

Table 20 (cont'd)

Condition °F/% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Hunter "b" Value:										
100/80	34.6	34.7	31.2	33.55	.73	35.5	33.9	29.8	33.07	2.81
100/57	37.6	34.8	30.6	34.33	.72	37.0	33.8	30.2	33.68	.50
70/80	40.1	34.5	31.5	35.39	1.01	36.3	31.6	30.8	32.89	1.29
70/57	39.7	34.2	31.6	35.16	.90	35.1	34.7	30.5	33.42	.60
40/57	36.7	34.3	30.3	33.78	.78	33.8	34.0	30.8	32.86	.99
0/amb	38.0	34.3	31.7	34.63	.66	36.8	34.8	30.5	34.03	.66
std.dif.,cans	.87	.53	.95	.80	-	1.96	1.13	.82	1.39	-
sign.dif., 5%	1.50	NS	NS	.69	1.29[a]	NS	1.95	NS	1.14	2.23[a]
Mean	37.79	34.47	31.16	34.47	.68[b]	35.74	33.80	30.43	33.32	.73[b]
Hunter a/b Ratio:										
100/80	-.037	.032	-.322	-.102	.016	-.074	.062	-.290	-.092	.059
100/57	-.110	.042	-.323	-.121	.024	-.049	.058	-.293	-.086	.115
70/80	-.137	.030	-.321	-.137	.023	.023	.035	-.275	-.066	.107
70/57	-.157	.138	-.288	-.101	.019	-.143	.024	-.290	-.130	.036
40/57	-.189	.025	-.313	-.154	.031	-.084	.057	-.317	-.108	.068
0/amb	-.115	.131	-.310	-.093	.027	-.139	.070	-.331	-.125	.063
std.dif.,cans	.028	.025	.016	.024	-	.132	.028	.024	.079	-
sign.dif., 5%	.048	.042	.029	.022	.037[a]	NS	.038	.037	.059	.127[a]
Mean	-.125	.066	-.313	-.118	.023[b]	-.077	.051	-.299	-.101	.032[b]

[a] Significant difference for items in rooms.
[b] Significant difference for item means.

2210.6 FTV

TABLE 21

HUNTER COLOR VALUES FOR CARBOHYDRATE SUPPLEMENTS, CHERRY TYPE

Condition °F/% r.h.	18 months CD11	18 months CD12	18 months CD13	18 months Mean	18 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Hunter L Value:										
100/80	39.0	56.4	43.9	46.43	.57	38.9	56.3	46.0	47.10	1.45
100/57	45.4	56.8	43.8	48.70	1.20	40.8	56.0	46.7	47.83	3.58
70/80	40.5	56.4	42.3	46.38	.99	39.1	55.5	46.0	46.83	1.41
70/57	43.8	56.5	43.1	47.81	1.65	39.7	55.8	44.7	46.72	2.68
40/57	41.7	55.9	44.8	47.45	1.52	40.4	56.1	44.2	46.91	1.50
0/amb	37.4	56.1	42.6	45.36	1.86	41.7	57.4	45.2	48.13	1.29
std.dif.,cans	.87	1.75	1.34	1.37	-	2.48	1.27	2.49	2.16	-
sign.dif., 5%	1.51	NS	2.28	1.18	2.20[a]	NS	NS	NS	NS	3.46[a]
Mean	41.30	56.34	43.42	47.02	.95[b]	40.10	56.18	45.47	47.25	.88[b]
Hunter "a" Value:										
100/80	19.7	19.5	12.1	17.06	1.20	16.6	21.8	13.5	17.30	3.94
100/57	11.7	18.2	14.2	14.71	1.41	14.7	21.7	11.1	15.82	3.91
70/80	13.6	19.2	11.3	14.72	.13	13.7	23.3	9.6	15.52	1.77
70/57	8.4	18.2	12.3	12.93	1.81	16.3	24.5	11.5	17.44	1.71
40/57	11.5	19.9	10.3	13.92	2.95	14.7	22.9	10.9	16.17	3.45
0/amb	18.7	20.7	14.1	17.85	2.39	13.7	19.6	12.9	15.41	1.13
std.dif.,cans	1.03	2.58	2.42	2.13	-	3.57	2.08	2.82	2.89	-
sign.dif., 5%	1.78	NS	3.90	1.83	3.41[a]	NS	3.54	NS	1.91	4.63[a]
Mean	13.93	19.28	12.38	15.20	1.47[b]	14.95	22.29	11.58	16.28	1.43[b]

(cont'd)

Table 21 (cont'd)

Condition °F/% r.h.	18 months CD11	18 months CD12	18 months CD13	18 months Mean	18 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Hunter "b" Value:										
100/80	3.9	6.6	4.2	4.87	.31	5.9	8.7	3.2	5.94	1.29
100/57	3.3	6.8	3.5	4.54	.37	6.1	7.4	4.2	5.91	.85
70/80	4.1	6.9	4.4	5.15	.54	6.5	8.7	5.3	6.82	.39
70/57	4.2	7.0	3.6	4.91	.60	5.8	9.9	6.3	7.31	.33
40/57	3.7	6.9	3.3	4.65	.85	5.7	10.3	5.5	7.18	.16
0/amb	4.5	6.5	3.4	4.79	.68	5.6	9.1	5.2	6.65	.81
std.dif.,cans	.62	.62	.50	.59	–	.54	.89	.76	.75	–
sign.dif., 5%	NS	NS	.85	.50	.94[a]	.80	1.54	1.32	.67	1.19[a]
Mean	3.95	6.78	3.73	4.82	.30[b]	5.93	9.02	4.95	6.63	.49[b]
Hunter a/b Ratio:										
100/80	5.08	2.97	2.89	3.50	.17	2.82	2.49	4.22	2.91	1.36
100/57	3.53	2.67	4.09	3.24	.32	2.39	2.94	2.64	2.68	1.13
70/80	3.30	2.78	2.57	2.86	.29	2.11	2.67	1.83	2.28	.21
70/57	2.01	2.60	3.43	2.63	.19	2.83	2.49	1.82	2.39	.21
40/57	3.10	2.89	3.08	2.99	1.16	2.59	2.22	1.96	2.25	.65
0/amb	4.17	3.18	4.19	3.73	.41	2.45	2.15	2.48	2.32	.54
std.dif.,cans	.70	.16	.63	.55	–	.76	.20	1.16	.81	–
sign.dif., 5%	1.21	.27	1.07	.47	.88[a]	NS	.34	1.97	.70	1.30[a]
Mean	3.53	2.34	3.32	3.15	.40[b]	2.52	2.54	2.34	2.45	NS[b]

[a]Significant difference for items in rooms.
[b]Significant difference for item means.

TABLE 22

MOISTURE CONTENT AND pH VALUES OF CARBOHYDRATE SUPPLEMENTS

Condition °F/% r.h.	18 months CD11	18 months CD12	18 months CD13	18 months Mean	18 months Std.dif. cans	24 months CD11	24 months CD12	24 months CD13	24 months Mean	24 months Std.dif. cans
Moisture Content: percent										
100/80	1.29	1.18	1.44	1.30	.02	1.29	1.20	1.64	1.38	.05
100/57	1.78	1.21	1.42	1.47	.10	1.34	1.20	1.63	1.39	.10
70/80	1.77	1.24	1.37	1.46	.08	.99	1.51	1.52	1.34	.16
70/57	1.63	1.29	1.29	1.42	.11	.88	1.54	1.64	1.36	.05
40/57	1.61	1.33	1.35	1.43	.03	.79	1.51	1.70	1.33	.07
0/amb	1.78	1.29	1.43	1.50	.19	1.55	1.52	1.69	1.58	.04
std.dif.,cans	.15	.09	.07	.11	–	.13	.04	.07	.09	–
sign.dif., 5%	.25	.14	.12	.09	.18[a]	.23	.06	.11	.08	.14[a]
Mean	1.65	1.26	1.38	1.43	.09[b]	1.14	1.41	1.64	1.40	.13[b]
pH Values: (1 + 1 dilution)[c]										
100/80	6.48	6.53	6.61	6.54	.08	6.31	6.38	6.59	6.43	.12
100/57	6.53	6.61	6.77	6.64	.17	6.56	6.53	6.60	6.59	.10
70/80	6.78	6.68	6.77	6.75	.15	6.55	6.64	6.65	6.61	.06
70/57	6.27	6.84	6.95	6.69	.03	5.73	6.51	6.69	6.3[illegible]	.12
40/57	6.68	6.68	6.86	6.74	.08	5.81	6.58	6.66	6.3[illegible]	.14
0/amb	6.82	6.74	6.92	6.83	.11	6.50	6.66	6.73	6.6[illegible]	.07
std.dif.,cans	.17	.08	.04	.11	–	.15	.10	.04	.11	–
sign.dif., 5%	.42	.18	.10	.10	.10[a]	.26	.16	.06	.09	.16[a]
Mean	6.59	6.68	6.81	6.70	.06[b]	6.24	6.55	6.66	6.49	.12[b]

[a]Significant difference for items in rooms.
[b]Significant difference for item means.
[c]Dilution was noted incorrectly at 1 + 3 in Status Reports #8 and #10 and Annual Reports #II and #III; dilution used was 1 + 1, with deionized water.

TABLE 23

SUGAR CONTENTS OF CARBOHYDRATE SUPPLEMENTS

[illegible]	18 months					24 months				
	CD11	CD12	CD13	Mean	Std.dif. cans	CD11	CD12	CD13	Mean	Std.dif. cans
Dextrose: percent										
100/80	19.0	16.1	19.0	18.03	.78	19.2	16.3	18.1	17.88	1.76
100/57	16.8	16.0	17.5	16.79	.64	17.8	16.4	17.5	17.24	.63
70/80	17.4	16.0	17.9	17.08	.33	17.8	16.6	18.2	17.51	.60
70/57	18.0	16.0	18.8	17.63	.27	20.0	16.4	17.8	18.07	.51
40/57	17.3	16.2	18.5	17.30	.26	20.2	16.1	18.7	18.35	.43
0/amb	17.5	16.0	18.6	17.35	.12	16.7	16.4	17.0	16.69	.13
std.dif.,cans	.51	.09	.60	.46	-	1.30	.48	.47	.85	-
sign.dif., 5%	.89	.14	1.02	.40	.71[a]	2.25	NS	.84	.73	.98[a]
Mean	17.67	16.03	18.38	17.36	.36[b]	18.62	16.35	17.90	17.62	.52[b]
Sucrose: percent										
100/80	59.5	67.6	61.6	62.90	1.41	61.9	65.1	64.7	63.89	1.81
100/57	63.8	67.5	64.0	65.09	.58	63.8	65.3	62.6	63.91	.72
70/80	64.4	67.5	63.1	65.01	.52	63.7	66.9	61.8	64.16	1.79
70/57	63.3	67.3	62.6	64.37	.43	57.0	66.5	62.6	62.05	1.47
40/57	64.0	67.3	63.5	64.96	.27	56.7	65.8	60.8	61.11	1.18
0/amb	63.7	67.8	61.0	64.16	.93	64.8	65.4	63.8	64.65	.56
std.dif.,cans	.56	.39	1.18	.79	-	1.08	1.29	1.61	1.34	-
sign.dif., 5%	.96	NS	2.01	.73	1.11[a]	1.87	NS	2.79	1.15	2.06[a]
Mean	63.11	67.51	62.63	64.41	.78[b]	61.33	65.86	62.69	63.29	1.26[b]

(cont'd)

Table 23 (cont'd)

Condition °F/% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Total Sugar: percent										
100/80	78.5	83.7	80.6	80.93	.69	81.2	81.4	82.8	81.77	2.77
100/57	80.6	85.5	81.5	81.88	.23	81.6	81.7	80.1	81.15	1.17
70/80	81.8	83.5	81.0	82.09	.74	81.5	83.5	80.0	81.67	2.36
70/57	81.3	83.3	81.4	82.00	.66	77.0	82.9	80.4	80.10	1.56
40/57	81.3	83.5	82.0	82.26	.16	76.9	81.9	79.5	79.46	.98
0/amb	81.2	83.8	79.6	81.51	.89	81.5	81.8	80.8	81.34	.55
std.dif.,cans	.60	.39	.81	.63	-	1.60	1.77	1.86	1.75	-
sign.dif., 5%	1.04	NS	1.43	.54	1.01[a]	2.77	NS	3.21	1.58	2.54[a]
mean	80.78	83.54	81.01	81.77	.61[b]	79.95	82.21	80.59	80.91	1.10[b]
Dextrose/Sucrose Ratio:										
100/80	.319	.238	.309	.287	.020	.311	.249	.280	.280	.028
100/57	.264	.237	.274	.258	.013	.278	.251	.280	.270	.009
70/80	.271	.236	.283	.263	.005	.279	.248	.294	.273	.004
70/57	.285	.238	.301	.274	.003	.351	.246	.285	.291	.011
40/57	.269	.240	.291	.266	.005	.356	.245	.308	.300	.014
0/amb	.275	.236	.305	.270	.006	.258	.250	.266	.258	.004
std.dif.,cans	.010	.003	.015	.011	-	.023	.003	.009	.014	-
sign.dif., 5%	.017	.004	.025	.009	.015[a]	.040	.005	.015	.012	.020[a]
mean	.280	.237	.293	.270	.009[b]	.304	.248	.285	.278	.013[b]

[a]Significant difference for items in rooms.
[b]Significant difference for item means.

TABLE 24

SENSORY SCORES FOR AROMA AND FLAVOR OF CARBOHYDRATE SUPPLEMENT
(scale from 10 = excellent to 1 = poor)

Condition °F/% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Aroma:										
100/80	6.5	6.9	7.2	6.87	.29	6.5	6.8	6.8	6.70	.26
100/57	6.2	7.2	7.2	6.87	.33	6.3	6.7	6.6	6.53	.17
70/80	6.6	7.2	7.4	7.07	.52	7.0	6.7	6.8	6.83	.35
70/57	7.3	6.9	7.4	7.20	.44	7.5	6.9	7.2	7.20	.17
40/57	7.3	7.3	7.5	7.37	.39	7.6	7.5	7.5	7.53	.59
0/amb	7.5	7.6	7.6	7.57	.74	7.2	7.7	7.8	7.57	.35
std.dif.,cans	.49	.54	.38	.48	–	.28	.44	.30	.35	–
sign.dif., 5%	.85	NS	NS	.41	.76[a]	.48	.75	.52	.31	.56[a]
Mean	6.90	7.18	7.38	7.16	.38[b]	7.02	7.05	7.12	7.06	NS[b]
Flavor:										
100/80	6.7	6.8	7.3	6.93	.29	6.7	6.8	7.0	6.83	.48
100/57	6.5	7.2	7.2	6.97	.58	6.8	6.9	7.0	6.90	.35
70/80	7.0	7.3	7.7	7.33	.44	7.7	7.1	7.7	7.50	.39
70/57	7.6	7.0	8.2	7.60	.00	7.2	7.4	7.5	7.37	.35
40/57	7.4	7.4	7.9	7.53	.48	7.5	7.6	8.0	7.70	.48
0/amb	7.6	7.5	8.3	7.80	.85	7.5	7.6	8.3	7.80	.37
std.dif.,cans	.60	.53	.37	.51	–	.44	.26	.49	.41	–
sign.dif., 5%	1.02	NS	.64	.48	.82[a]	.75	.45	.84	.35	.65[a]
Mean	7.13	7.20	7.77	7.37	.31[b]	7.23	7.23	7.58	7.35	.27[b]

[a] Significant difference for items in rooms.
[b] Significant difference for item means.

TABLE 25

HEDONIC RATINGS FOR AROMA, FLAVOR AND PALATABILITY OF CARBOHYDRATE SUPPLEMENTS

Condition	18 months					24 months				
°F/% r.h.	CD11	CD12	CD13	Mean	Std.dif. cans	CD11	CD12	CD1	Mean	Std.dif. cans
Aroma:										
100/80	6.38	6.50	6.76	6.55	.28	5.74	6.74	6.52	6.33	.25
100/57	5.98	6.86	6.58	6.47	.32	5.30	6.44	6.46	6.23	.32
70/80	6.42	6.80	6.84	6.69	.20	6.30	6.80	6.56	6.55	.51
70/57	6.58	6.66	7.00	6.75	.17	6.50	6.84	6.76	6.70	.21
40/57	6.60	6.80	6.82	6.74	.11	6.66	6.92	6.78	6.79	.25
0/amb	6.60	6.62	7.06	6.76	.52	5.52	7.10	6.94	6.85	.49
std.dif.,cans	.41	.26	.17	.30	–	.23	.21	.53	.36	–
sign.dif., 5%	NS	NS	.29	.26	.48[a]	.40	.40	NS	.33	.57[a]
Mean	6.43	6.71	6.84	6.66	.21[b]	6.25	6.81	6.67	6.53	.21[b]
Flavor:										
100/80	6.86	6.74	6.78	6.79	.14	6.12	6.36	6.94	6.64	.44
100/57	6.32	7.00	6.84	6.72	.22	6.18	6.50	6.76	6.48	.47
70/80	6.86	7.00	6.92	6.93	.21	6.78	6.94	6.86	6.86	.51
70/57	6.90	6.78	7.16	6.95	.11	6.64	7.02	7.04	6.90	.29
40/57	7.06	7.04	6.96	7.02	.16	7.00	7.04	7.00	7.01	.27
0/amb	6.98	6.72	7.12	6.94	.41	6.74	7.32	7.24	7.10	.49
std.dif.,cans	.27	.27	.12	.23	–	.29	.16	.65	.42	–
sign.dif., 5%	.45	NS	.21	.20	.37[a]	.50	.28	NS	.38	.68[a]
Mean	6.83	6.88	6.96	6.89	NS[b]	6.58	6.95	6.97	6.83	.20[b]

(cont'd)

Table 25 (cont'd)

Condition °F/% r.h.	18 months CD11	CD12	CD13	Mean	Std.dif. cans	24 months CD11	CD12	CD13	Mean	Std.dif. cans
Palatability:										
100/80	6.82	6.68	6.78	6.76	.04	6.24	6.82	6.78	6.61	.44
100/57	6.18	6.92	6.84	6.65	.15	6.20	6.54	6.70	6.48	.40
70/80	6.90	6.98	7.02	6.97	.18	6.66	6.96	6.80	6.81	.48
70/57	6.84	6.82	7.10	6.92	.08	6.64	7.00	6.88	6.84	.39
40/57	7.00	6.92	7.02	6.98	.20	6.86	6.98	6.88	6.91	.30
0/amb	6.88	6.78	7.06	6.91	.41	6.56	7.32	7.06	6.98	.54
std.dif.,cans	.29	.21	.10	.21	–	.36	.09	.65	.43	–
sign.dif., 5%	.49	NS	.18	.19	.34[a]	.62	.15	NS	.39	.69[a]
Mean	6.77	6.85	6.97	6.86	NS[b]	6.53	6.94	6.85	6.77	.20[b]

[a]Significant difference for items in rooms.
[b]Significant difference for item means.

TABLE 26

CORRELATIONS OF PALATABILITY RATINGS WITH OTHER MEASUREMENTS
(r, simple correlation coefficients)

Palatability with:

Products 24 M.C.	Hunter Color Values L	"a"	"b"	a/b	pH Value	Moisture Content	Sugar Contents dextrose	sucrose	total	dex/sucr	Total Quality score
Candies: lemon											
CD11	-.04[illegible]	-.079	-.266	-.105	-.432	-.511	+.263	-.481	-.555	+.361	+.602[a]
12	-.160	+.035	+.209	+.001	+.259	+.728[b]	+.001	-.116	+.092	-.092	+.312[b]
13	-.009	-.204	+.175	-.169	+.461	+.124	+.110	+.234	+.230	-.033	+.396
All	+.216	+.025	-.300	-.002	+.231	+.211	-.222	+.190	+.129	-.206	+.524[b]
Candies: cherry											
CD11	-.087	-.160	-.001	-.126	-.421	-.534	+.007	-.298	-.412	+.141	-[c]
12	+.327	-.066	+.536	-.768[b]	+.543	+.759[b]	-.107	+.031	-.001	-.334	-[c]
13	-.526	+.336	-.121	+.256	+.263	-.203	+.054	-.006	+.029	+.036	-[c]
All	+.405[a]	+.194	+.260	+.021	+.165	+.219	-.285	+.160	+.040	-.242	-[c]

[a] Significant at the 5% level of probability.
[b] Significant at the 1% level of probability.
[c] Quality scores were based on total samples of carbohydrate supplements, lemon and cherry types combined.

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13 ABSTRACT

Progress is reported on storage of (1) 4 lots of survival crackers, 4 lots of survival biscuits, and 2 lots of bulgur wafers for 36 months, and (2) 3 lots of carbohydrate supplement for 18 and 24 months, at 100°F/80% r.h., 100°/57%, 70°/80%, 70°/57%, 40°/57%, and 0°F. Two special cases of biscuits from approximately 42 months storage in a GSA common storage warehouse are also reported on. Data include (a) bursting strength, moisture, and general condition of V3c fiberboard cases, (b) corrosion, coating defects, and leakage of 2 ½-gal. and 5-gal. metal cans, (c) general package and product condition, (d) residual oxygen, fracture strength, moisture, peroxides, and free fatty acids of the wheat products, (e) moisture, pH, and sugars of the supplements, and (f) color, sensory quality and hedonic ratings for all products.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
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Containers	9					
Food	9					
Rations	4		4			
Survival	4		4			
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